APPLYING THEORY OF PLANNED BEHAVIOR MODEL ON STUDYINGTEACHERS' CHANGE IN MATHEMATICS INSTRUCTION

Youngyool Oh

Gwangju National University of Education

The present study aims at gaining an understanding of structures underlying Korean teachers' willingness to change their traditionally-oriented mathematics teaching practice toward reform-oriented mathematics instruction. Elementary school teachers from a metropolitan city of Korea (N = 281) participated in this study. To deal with this problem, this study employees the Theory of Planned Behavior as a research framework and Structural Equation Modeling using AMOS 4.0 as a statistical model was used to analyze the data. The findings indicate that the TPB is a useful model for explaining teacher change in teaching practice, suggesting that beliefs-based programs will be effective for successful teacher education.

A recent view of educational reform calls for the fundamental change in teachers' instructional practice. This strong demand for change had been raised from diverse areas of the society as a result of considerable agreement that traditional schooling had failed to educate students in mathematics. In accordance with the needs for change in the method of teaching mathematics, research on the teaching and learning of mathematics has drastically increased over the last decade. Using the Eric database, Lubienski and Bowen (2000) found that approximately 20 percent of the articles related to elementary education in mathematics investigated teacher behaviors. This study revealed that more attention was increasingly oriented toward teachers' beliefs and knowledge regarding their roles in changing traditional ways of teaching mathematics.

The results of some studies (Franke, Fennema, & Carpenter, 1997; Raymond, 1997; Thompson, 1992) suggested that mathematics teaching seems to be more effective when teachers' beliefs are consistent with their teaching practices. Thus, teachers' beliefs about mathematics as well as its teaching and learning are now considered as essential component of good teaching. Although plenty of qualitative studies have been conducted on this area, a few quantitative studies focused on structural approach among variables have been found. By adopting a statistical method, the present study is interested in more deeply understanding the structural phenomenon underlying teachers' willingness to change their traditionally-oriented teaching practice in mathematics and their beliefs.

THEORETICAL BACKGROUND

Good teaching is not solely based on a teacher's effective transmission of mathematical knowledge. Rather, decades of research on mathematics teaching and learning reveal a consistent assumption that good mathematics teaching is based on how teachers view mathematics, their beliefs of how mathematics should be taught, and the extent of a teacher's mathematical knowledge.

Throughout the years, the image of good teaching has shifted back and forth between two conflicting philosophies. On the one hand is what has been called a "traditional," "teacher-centered," "rote-learning," and "drill-and-practice" approach. On the other hand, one finds a "progressive," "students-centered," "meaningful learning," and "reform-oriented" approach. Teachers that follow the traditional model have been metaphorically described as "knowledge distributors" given that they directly transmit what they know into their students' heads. On the other hand, reform-oriented teachers have been seen as "facilitators," or "stimulators" given that they assist students' mathematical learning as they create a learning environment that reflect students' ideas.

Recently, studies on teachers' beliefs have been one of the most pursued research areas in mathematics education due to the realization of their importance on teaching and students learning. Some studies (Raymond, 1997; Brown & Borko, 1992; Thompson, 1992) have focused on examining the consistency between teachers' beliefs and their actual teaching practice in the classroom, and other studies have found some constraints in teaching in a reform-oriented way. Generally speaking, there is an agreement that teachers are required to change their beliefs toward the reform-minded and their beliefs need to be consistent with actual teaching practice in their classroom in order to teach mathematics more effectively.

The theory of planned behavior (TPB) proposed by Fishbein and Ajzen (1975) has gained one of the most successful psychological models used to predict and understand human behavior that is socially relevant. Although few studies have employed the TPB in mathematics education, recent success in other academic areas, such as science education (Crawley & Kobala, 1994; Kobala & Crawley, 1992) and special education (Kalivoda & Higbee, 1998) has implied that this theory can play a significant role in understanding a structural approach to teacher change in mathematics teaching practice. The TPB is grounded on the assumption that "human beings are usually quite rational and make systematic use of the information available to them" (Ajzen & Fishbein, 1980, p. 5). The model proposes a causal relationship among the variables that influence the target behavior. According to the model, teachers' change in mathematics teaching practice of mathematics is best predicted from teachers' intention to teach mathematics in a students-centered way, called behavioral intention (BI). In turn, behavioral intention is a function of the other three predictor variables; that is, attitude toward the behavior (AB), subjective norm (SN), and perceived behavioral control (PBC). Thus, the theoretical TPB model was conceptualized into the structural equation model (SEM) to investigate teachers' change in mathematics instructional practice.

RESEARCH METHODS

The population of the present study included all elementary school teachers who teach mathematics as part of their regular responsibility in a metropolitan city of Korea. Convenient sampling was used to select 21 schools to guarantee diversity in elementary mathematics teaching contexts regarding school educational goals, district resources, and socio-economic status. Finally, a total of 379 teachers completed a questionnaire used in this study. After both questionnaires with severely missing entries and outliers were

deleted from the data, a total of 281 subjects, 177 reform-minded and 64-traditionally-oriented, were considered as valid for final analysis.

The development of the instrument used in this study followed the guidelines recommended by Ajzen and Fishbein (1980). Among the components measured were behavioral intention, attitudes toward the behavior, subjective norms, and perceived behavioral controls. Teachers' behavioral intention toward the reform-oriented mathematics teaching was measured by their responses to the following 7-point likert scale: *I intend to teach mathematics in a students-centered way (e.g., exploring concepts, making the classroom as learning environment, and providing a variety of opportunities to learn*). Attitude toward the behavior, subjective norm, and perceived behavioral controls were measure both directly and indirectly. For instance, a direct measure of subjective norm was measured by teachers' response to the statement "*Most people who are important to me think I should teach mathematics in a students-centered way*" by a 7-point likely-unlikely scale. On the other hand, an exemplary statement for the indirect measure of subject norm is "*My students think I should teach mathematics in a students-centered way*" by a likely-unlikely scale.

Structural equation modeling (SEM) with AMOS, standing for Analysis of Moment Structure (Arbukle & Wothke, 1995), was adopted to analyze the data. The structural equation modeling includes two different variables: observed variables and latent (unobserved) variables. Latent variables are not directly measured but estimated from observed variables, which are direct measured. Eventually, many constructs of interest are unobservable in nature. In the theory of planned behavior model briefly described above, behavioral intention, attitude, subjective norm, and perceived behavioral control may not be directly observed; rather, there latent variables can be calculated from measured indicators. The theoretical framework of theory of planned behavior is consistent with the purpose of structural equation modeling for analysis in the sense that the structural equation modeling allows a researcher to evaluate an entire on a "micro-level" and to test individual effects on a "micro-level" (Kline, 1998, p. 13).

RESULTS

The structural equation modeling (SEM) of the theory of planned behavior (TPB) consists of measurement and structural components. The SEM designed for the present study includes the directly observed variables and the unobserved latent variables that are associated with the observed variables. The SEM using AMOS 4.0 for the TPB is based on the theoretically-grounded causal relationships between the latent variables, such as teachers' behavioral intention, attitudinal beliefs, subjective norms, and perceived behavioral controls toward changing traditionally-oriented instructional practice in mathematics.

The researcher first hypothesized for the structural part of the model that the teachers' willingness to teach in a reform-oriented mathematics instruction is dependent upon their attitudinal beliefs, subjective norms, and perceived behavioral controls. In the measurement model, a set of connections between the observed variables and the latent

variables were considered to see how well the observed variables are predicted by the latent variables.

For model 1 that was formulated on the basis of the TPB, maximum likelihood estimation gives a chi-square value of 44.80 with 11 degrees of freedom (p = .00), indicating that the original model did not appropriately fit the data. Another fit index, RMSEA = .11, also points out that the first hypothetical model did not adequately explain the data. That is, it seems to be concluded that the model 1 based on the theory of planned behavior cannot be directly adopted to predict and understand the phenomenon of how much elementary teachers are willing to change their traditional teaching practices toward the reform-oriented way of teaching mathematics.

According to Kelloway (1998), it seems acceptable to modify the model and assess its fit if the collected data were from one sample. Two sources in the present study were considered for generating an alternative model, such as correlation among the variables and theoretical grounds. Correlation analyses among the variables pointed out that SN was significantly correlated with ABI at the level of p = .01. This result indicated that the indirect measure of attitudinal beliefs shared its variance with subjective norm. Theoretically, it was not surprising that attitudinal beliefs was associated with subjective norms, considering that teachers' behavioral beliefs are influenced to some degree by expectations of some important others regarding teaching mathematics through a students-centered way (Raymond, 1997). Thus, an alternative model (model 2) was generated as a result of examining model 1. As shown in figure 1, one more path for the alternative model was added from subjective norm (SN), a latent independent variable, to an observed variable of attitude about the behavior (ABI).

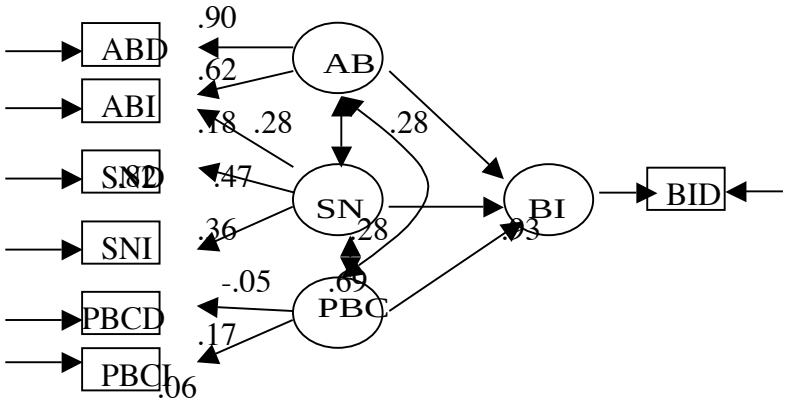

Figure 1. A structural equation of TPB model 2.

The results of measurement part of model 2 shown in figure 1 present that AB accounts for 81 percent of the variance in the direct measure of attitudinal beliefs (ABD). It can be interpreted that its reliability is at least 0.81 (Arbuckle & Wothke, 1995). Similarly, SN explains about 67 percent of the variance in SND. The Analysis of model 2 for the structural part presents the results of causal relationships among the latent variables used for the model. As in model 1, fit indices using maximum likelihood estimation were used to assess the adequacy of the structural part of model 2. Fit indices of both χ^2 (18.39) and χ^2 /df (1.84) indicated that model 2 moderately fit the data (p = .05). Additionally, the value of RMSEA (.06) suggested that model 2 is an acceptable fit to the data. Thus, we may conclude that model 2 generated on the basis of theoretical grounds and exploratory analysis significantly improved the fit of the model to the data, implying that the revised model of theory of planned behavior better fit the data on teachers' change in mathematics teaching practice.

A particular interest in this study was given to whether the TPB model can be applied to the reform-oriented group of teachers regarding mathematics instructional practice. Thus, this study examined how well model 1 based on the theory of planned behavior fits the data, consisting of 177 reform-oriented elementary teachers toward mathematics instruction. Results for the reform-oriented group of teachers indicated the significant improvement regarding the prediction of latent variables on observed variables. For instance, attitudinal beliefs account for 67 and 70 percents of ABD and ABI, respectively, while 80 and 65 percents of variances in SND and SNI are accounted for by teachers' beliefs about important others. Considering the relationships among the latent variables, the standardized path coefficients for the structural portion of the model showed that teachers' behavioral intention to teach mathematics in a reform-oriented way was best predicted by their attitudinal beliefs with β = .60. The values of χ^2 /df (1.38) with p = .17 and RMSEA (.05) indicated that the original TPB model is a good model for the data. This result implies that the theory of planned behavior appropriately explains regarding predicting and understanding the structure underlying reform-oriented teachers' willingness to teach mathematics in a students-centered way.

CONCLUSION

This study used a quantitative approach to provide a general perspective of how much teachers are willing to change their traditionally-oriented teaching practices toward reform-oriented way of teaching mathematics. The results indicate that the theory of planned behavior provides an adequate explanation on teachers' instructional change in mathematics. The present study shows that teachers' willingness to teach mathematics in a students-centered way is significantly influenced by teachers' attitudinal beliefs toward the reform-oriented way of teaching mathematics, their perceptions about important others (e.g., students and parents), and some control difficulties (e.g., shortage of instructional resources and teacher/students ratio). The findings of the present study support belief-based teachers' education programs, focusing on changing teachers'

traditionally-oriented perspectives on teaching mathematics toward the reform-oriented way.

The analysis on the reform-oriented group of teachers indicates that the theory of planned behavior as a research framework is well fitted to the data. This finding implies that the model might be more useful for explaining the reform-oriented group of teachers than the traditionally-oriented group of teachers. In other words, teachers with reform-mind tend to have more favorable perception about teaching in a students-centered way. Hence, they are more highly expected to accept the reform-oriented way of teaching mathematics.

The findings of the present study demonstrate what mathematics educators, teacher educators, and reform leaders need to know and what they should do to help teachers become reform-minded. In light of these findings, the effectiveness of teacher education programs for elementary teachers in Korea needs to be reconsidered. For instance, teachers participating in this study negatively evaluated the effectiveness of teacher education programs and noted the lack of opportunities to learn about reform-oriented instructional practices. By identifying factors essential to effective teaching, this study also enables mathematics teachers to follow the recommendations suggested by reform documents for mathematics.

References

Ajzen, I., & Fishbein, M. (1980). *Understanding attitudes and predicting social behavior*. Englewood Cliffs, NJ: Prentice-Hall.

Arbuckle, J. L., & Wothke, W. (1995). *Amos 4.0 user's guide*. Chicage, IL: SmallWaters Corporation.

Brown, C. A., & Borko, H. (1992). Becoming a mathematics teacher. In D. A. Grouws (Ed.), *Handbook of research on mathematics teaching and learning* (pp. 209-239). New York: Macmillan.

Crawley, F. E., & Kobala, T. R. Jr. (1994). *Attitude research in science education: Contemporary models and methods*. Science Education, 78(1), 35-55.

Fishbein, M., & Ajzen, I. (1975). *Belief, attitude, intention and behavior: An introduction to theory and research*. London: Addison-Wesley Publishing.

Franke, M., Fennema, E., & Carpenter, T. (1997). Changing teachers: intentions between beliefs and classroom practice. In E. Fennema & B. S. Nelson (Eds.), *Mathematics teachers in transition* (pp. 225-282). Mahwah, NJ: Lawrence Erlbaum Associates.

Kalivoda, K. S., & Higbee, J. L. (1998). Influencing faculty attitudes toward accommodating students with disabilities: A theoretical approach. *Learning Assistance Review*, 3(2), 12-25.

Kelloway, E. K. (1998). *Using LISREL for structural equation modeling: A researcher's guide*. Thousand Oaks: SAGE Publications.

Kline, R. B. (1998). *Principles and practice of structural equation modeling*. New York: Guilford Press.

Kobala, T. R. Jr., & Crawley, F. E. (1992). Attitude-behavior change in science education: Part III, results of an ongoing research agenda. (*ERIC Document Reproduction Service* No. ED 356 142).

Lubienski, S. T., & Bowen, A. (2000). Who's counting? A survey of mathematics education research 1982-1998. *Journal for Research in Mathematics Education*, 31(5), 626-633.

Raymond, A. M. (1997). Inconsistency between a beginning elementary teacher's mathematics beliefs and teaching practice. *Journal for Research in Mathematics Education*, 28(5), 550-576.

Thompson, A. G. (1992). Teachers' beliefs and conceptions: a synthesis of the research. In D. A. Grouws (Ed.), *Handbook of research on mathematics teaching and learning* (pp. 209-239). New York: Macmillan.

Page Intentionally Left Blank