J. Korean Soc. Math. Ed. Ser. D. (2023) 26(3), 121–125 ISSN 1226-6191
https://doi.org/10.7468/jksmed.2023.26.3.121 Online ISSN 2287-9943

EDITORIAL

Exploring Mathematical Modeling in Classrooms: Insights from Diverse Studies

Sunyoung Han[1], Jihyun Hwang[2]

[1] Associate Professor, Mathematics Education, Sungkyunkwan University, sy.han@skku.edu
[2] Assistant Professor, Mathematics Education, Korea National University of Education, jihyun-hwang@knue.ac.kr

Mathematical modeling has been a long-standing topic of discussion within the field of mathematics education and continues to hold great significance (Cai et al., 2014). The term mathematical modeling is often referred to as the goal of mathematics education, as a way to learn mathematics – epistemological modeling – and as a lens to understand the real world. Of course, the words, mathematical modeling, can be discussed from sociocultural, cognitive, realistic modeling perspectives (Kaiser, 2017).

Mathematical modeling has been continuously recognized as an important educational goal in mathematics subjects until now. In South Korea, mathematical modeling is officially recognized as an essential component of mathematical problem-solving competency within the 2015 revised mathematics curriculum. Consequently, mathematical modeling is given significant emphasis alongside mathematical problem-solving in Korean schools (Choi, 2017). This emphasis on mathematical modeling is not limited to a single country; it is a global phenomenon. For example, in the United States, mathematical modeling is presented as an important educational goal in the Common Core States Standards in Mathematics (CCSSM; National Governors Association Center for Best Practices & Council of Chief State School Officers, 2010). The National Council of Teachers in Mathematics (NCTM; Hirsch & McDuffie, 2016) also suggests several specific methods for implementing mathematical modeling in school mathematics classrooms. In addition, the Program for International Student Assessment (PISA) include the mathematical modeling process in their definition of mathematical literacy (OECD, 2017).

This recognition of the importance of mathematical modeling is amplified by the recent wave of the Fourth Industrial Revolution (Gravemeijer et al., 2017). In contemporary society, there is a growing demand for individuals who possess new skills in response to the rapid advancement of technology. The ability to understand and solve novel problems beyond performing simple routine tasks is required (OECD, 2017). This capacity to address human problems in specific contexts is at the core of problem-solving competency.

Moreover, mathematical modeling constitutes a vital component of this competency and serves as a means to cultivate problem-solving abilities (Zawojewski, 2010).

Despite the recognition of the importance of mathematical modeling, teachers and students shown in real mathematics classrooms still lack awareness and thorough understanding of mathematical modeling (Stillman et al., 2013). Teachers recognize the significance of mathematical modeling, but often struggle with its implementation. Likewise, students have limited experience with mathematical modeling, resulting in a restricted ability to utilize it effectively for problem-solving purposes.

Given these challenges, there is a pressing need for diverse and practical research initiatives aimed at helping both teachers and students appreciate the importance of mathematical modeling and its integration into mathematics classrooms. In response to these needs, this journal has planned a special issue on the topic of mathematical modeling, and we got six studies discussing various facets of research on mathematical modeling in this issue.

As we expected, this special issue has received an array of practical studies conducted in various classrooms. Li (2023), Xu (2023), Bardy and Fehlmann (2023), Alhammouri and DiNapoli (2023) introduced some cases using mathematical modeling in mathematics classrooms. These studies discussed what students and teachers explored in the mathematical modeling projects. The first three studies primarily focused on students' experiences with mathematical modeling tasks and projects, whereas the last one was regarding teachers' perspectives on mathematical modeling.

First, Li (2023) investigated students' statistical thinking through data. In Li's study, students were divided into small group to increase opportunities for peer collaboration and participated in a regression project. From the findings of this study, Li argued that collaborative learning environment was helpful for students' learning project, which in turn affected their statistical thinking. Li's research is meaningful in that it demonstrates mathematical modeling in the context of statistics, but the results are also practical in that they show what kind of environment is appropriate for students' mathematical modeling competence.

Secondly, Xu (2023) was more interested in geometry problems and discussed how to carry out mathematics inquiry teaching based on pattern similarity. Xu indicated the importance of providing students with opportunities to learn mathematics in a manner that mathematicians explore and discover mathematics based on pattern similarity. In this sense, Xu explored the example of how to guide students to carry out mathematics inquiring based on pattern similarity in classroom.

Thirdly, the study of Bardy and Fehlmann (2023) was another valuable contribution describing students' experiences of mathematical modeling in classrooms. Bardy and Fehlmann employed a tennis serve task and provided diverse levels of mathematical modeling that might be adoptive to students' mathematical competency levels. That is, Bardy and Fehlmann 's study showed that mathematical modeling on the same topic could be implemented at a level appropriate for middle school, high school, and college students.

These first three studies (Bardy & Fehlmann, 2023; Li, 2023; Xu, 2023) are

particularly valuable as they offer practical examples that can benefit both mathematics education researchers and teachers alike. Meanwhile, the biggest difficulty teachers have in using mathematical modeling is developing mathematical modeling tasks (Dogan, 2020). In this respect, the problems presented in these three studies and their cases are thought to be of great help to not only mathematics education researchers but also mathematics teachers.

The fourth study in this special issue conducted by Alhammouri and DiNapoli (2023) investigated the experiences of United States high school mathematics teachers in a professional development program focused on mathematical modeling and its enactment in schools. Among the papers in this special issue, this is the only study that analyzes teachers' perspectives. In South Korea, there are also very limited papers that study how well teachers know mathematical modeling and what their perspectives are on mathematical modeling (Hwang & Han, 2023). In this sense, the study by Alhammouri and DiNapoli is evaluated as providing an important case describing how teachers develop and implement mathematical modeling problems. Moreover, this study is meaningful in that it explored the perspectives of teachers who participated in training for mathematical modeling and examined how they actually enact in their classes. That is, this study explores aspects of the effectiveness of professional development program for mathematical modeling, and also examining how well teachers reflect the content of the training on their lessons.

The fifth study, conducted by Jeong et al. (2023), analyzed PISA 2012 data from six countries. They investigated the classification of leaner groups for students' mathematical modeling competency and the characteristics in each profile group for each country. It was interesting to see that students from each country were distributed in different proportions into the five profile groups, and also showed different achievements in mathematical modeling variables such as formulate, employ, and interpret. While the other papers in this special issue are studies conducted in one country, the study by Jeong et al. (2023) provides special implications through international comparison.

The last study by Song et al. (2023) investigated the extent to which Korean high school textbooks incorporate mathematical modeling tasks, and how much the tasks included in Korean high school textbooks provided students with the opportunities to engage in each stage of mathematical modeling process. Given that textbooks are the most commonly used educational materials in schools (van Zanten & van den Heuvel-Panhuizen, 2018), it is important to analyze how much they reflect mathematical modeling. According to the results of the study, Song et al. (2023) insisted that the materials for mathematical modeling need to include high-quality tasks that allow students to experience the entire process of mathematical modeling. Moreover, they acknowledged the limitations of textbooks in providing appropriate opportunities for mathematical modeling with a heavy emphasis on performing operations. Song et al.'s study examined three Korean textbooks. For the further studies, the textbooks that used in other countries might be examined in the same way to explore how much the textbook tasks are appropriate for mathematical modeling.

Inclusion of these six studies in this special issue offers a comprehensive

opportunity to explore the implementation of mathematical modeling in classrooms across multiple countries. We anticipate that the insights derived from these studies will provide valuable perspectives on recent research in mathematical modeling, guiding further inquiry in this field.

References

Alhammouri, A. M., & DiNapoli, J. (2023). Secondary teachers' perspectives on mathematical modeling and modeling mathematics: Discovery, appreciation, and conflict. *Research in Mathematical Modeling*, *26*(3), 203-265. https://doi.org/10.7468/jksmed.2023.26.3.203

Bardy, T., & Fehlmann, R. (2023). Mathematical modeling of the tennis serve: Adaptive tasks from middle and high school to college. *Research in Mathematical Modeling*, *26*(3), 167-202. https://doi.org/10.7468/jksmed.2023.26.3.167

Cai, J., Cirillo, M., Pelesko, J. A., Borromeo Ferri, R., Borba, M., Geiger, V., Stillman, G., English, L. D., Wake, G., Kaiser, G., & Kwon, O. N. (2014). Mathematical modeling in school education: Mathematical, cognitive, curricular, instructional and teacher education perspectives. Joint Meeting of PME 38 and PME-NA 36, Vancouver, Canada.

Choi, K. A. (2017). A study on literature review of mathematical modeling in mathematical competencies perspective. *Journal of the Korean School Mathematics Society*, *20*(2), 187-210. https://doi.org/10.30807/ksms.2017.20.2.006

Dogan, M. F. (2020). Evaluating pre-service teachers' design of mathematical modelling tasks. *International Journal of Innovation in Science and Mathematics Education*, *28*(1), 44-59. https://doi.org/10.30722/IJISME.28.01.004

Gravemeijer, K., Stephan, M., Julie, C., Lin, F.-L., & Ohtani, M. (2017). What mathematics education may prepare students for the society of the future? *International Journal of Science and Mathematics Education*, *15*(S1), 105-123. https://doi.org/10.1007/s10763-017-9814-6

Hirsch, C. R., & McDuffie, A. R. (2016). *Annual perspectives in mathematics education 2016: Mathematical modeling and modeling mathematics*. National Council of Teachers of Mathematics.

Hwang, S., & Han, S. (2023). A study on mathematical modeling trends in Korea. The Journal of Educational Research in Mathematics, 33(3), 639-666. https://doi.org/10.29275/jerm.2023.33.3.639

Jeong, S., Hwang, J., & Ahn, J. S. (2023). Investigating students' profiles of mathematical modeling: A latent profile analysis in PISA 2012. *Research in Mathematical Modeling*, *26*(3), 235-252. https://doi.org/10.7468/jksmed.2023.26.3.235

Kaiser, G. (2017). The teaching and learning of mathematical modeling. In J. Cai (Ed.), *Compendium for research in mathematics education* (pp. 267–291). National Council of Teachers of Mathematics.

Li, K. W. (2023). Fostering students' statistical thinking through data modelling. *Research in Mathematical Modeling*, *26*(3), 127-146. https://doi.org/10.7468/jksmed.2023.26.3.127

National Governors Association Center for Best Practices, & Council of Chief State School Officers. (2010). *Common core state standards for mathematics*. http://www.corestandards.org/the-standards/mathematics

OECD. (2017). *PISA 2015 assessment and analytical framework: Science, reading, mathematic, financial literacy, and collaborative problem solving* (revised edition ed.). OECD Publishing. https://doi.org/10.1787/9789264281820-en

Song, H. J., Ka, Y., & Hwang, J. (2023). Exploring opportunities for mathematical modeling in Korean high school textbooks: An analysis of exponential and logarithmic function tasks. *Research in Mathematical Modeling, 26*(3), 253-270. https://doi.org/10.7468/jksmed.2023.26.3.253

Stillman, G. A., Kaiser, G., Blum, W., & Brown, J. P. (Eds.), (2013). *Teaching mathematical modeling: Connecting to research and practice*. Springer. https://doi.org/10.1007/978-94-007-6540-5

van Zanten, M., & van den Heuvel-Panhuizen, M. (2018). Opportunity to learn problem solving in Dutch primary school mathematics textbooks. *ZDM, 50*(5), 827-838. https://doi.org/10.1007/s11858-018-0973-x

Xu, Y. (2023). Mathematics inquiring based on pattern similarity. *Research in Mathematical Modeling*, *26*(3), 147-166. https://doi.org/10.7468/jksmed.2023.26.3.147

Zawojewski, J. (2010). Problem solving versus modeling. In R. Lesh, P. L. Galbraith, C. R. Haines, & A. Hurford (Eds.), *Modeling students' mathematical modeling competencies: ICTMA 13* (pp. 237-244). Springer