J. Korean Soc. Math. Ed. Ser. D. (2022) 25(1), 45–63 ISSN 1226-6191
https://doi.org/10.7468/jksmed.2022.25.1.45 Online ISSN 2287-9943

RESEARCH ARTICLE

Examining Multicultural Education Research in Korean Mathematics Education

Eunhye Flavin[1], Sunghwan Hwang[2]

[1] Assistant Professor, Department of Education Studies, Stonehill College
[2] Teacher, Seoul Jangpyung Elementary School

Received: February 21, 2022 / Accepted: March 18, 2022 / Published online: March 23, 2022

Abstract

Multicultural students are a rapidly growing population in South Korea. Previous studies from the South Korean mathematics education community have reported low mathematics achievement levels of this population compared to Korean-born students. However, a systematic literature review was hardly employed. This study aims to synthesize the factors that affect the mathematics achievement of multicultural students to provide directions for future research and practical directions. Using an Opportunity-Propensity framework suggested by Byrnes and Miller, this study analyzed twenty-seven peer-reviewed journal articles on this topic. The results showed that the majority of the studies focused on the impact of the opportunity factors such as mathematics curriculum and teachers on mathematics achievements. We suggest that more studies regarding distal factors (e.g., students' prior achievement) and propensity factors (e.g., prerequisite knowledge) are needed.

Keywords Mathematics achievement, multicultural students, Systematic review, Opportunity-propensity model

• Corresponding Author: Sunghwan Hwang, email: ihwang413@gmail.com

I. INTRODUCTION

Over the past few decades, equity research has received great attention in the field of mathematics education (Solomon, Hough, & Gough, 2021). National Council of Teachers of Mathematics (NCTM, 2000, 2014) highlighted equity as one of the most important principles for school mathematics to ensure that all students learn this subject. Similarly, the International Congresses of Mathematics Education (ICME) and Psychology of Mathematics Education (PME) advocated that schools and teachers should provide sufficient support to maximize minority students' learning potentials (Jurdak, 2009). Some scholars believe that to ensure equity in mathematics education, all students should receive reasonable accommodations regardless of their race, ethnicity, and sex (Gutiérrez, 2002). Equity does not mean identical learning access. It does not mean that identical instruction will be provided for all students, but it involves appropriate support and resources to promote the access and attainment of the low achieving minority students. Therefore, minority students might need to be provided with more support to ensure their attainment in mathematics education (NCTM, 2014; Rubel, 2017). In this sense, studies on multicultural education, which are one of the most representative minority student groups, have been widely implemented in mathematics education to understand how to support their learning.

Meanwhile, previous South Korean mathematics education scholars had provided little attention to the studies about multicultural education. However, along with increasing numbers of the multicultural population, research on multicultural education has been initiated (Bae, Cho, & Kwon, 2017). The term multicultural students refer to students that have at least one parent who was born outside of South Korea (Ministry of Gender Equality & Family, 2019). The Korean Educational Development Institution (KEDI, 2021) reported that while Korea was regarded as a demographically homogenous country, the proportion of multicultural students has been steadily rising over time with the potential to grow sustainably for many years. For example, in 2012, only 0.7% of students (n = 46,954) were multicultural students. However, in 2021, 3.0% of students (n =160,056) were multicultural students, which indicates 4.3 times more multicultural students than previous results. Moreover, some multicultural students dropped out of school due to the complicated realities that amplified the difficulties in studying mathematics (Cho & Hwang, 2019). The increased dropout rates were found to escalate the likelihood of juvenile delinquency and social conflict (Ministry of Gender Equality & Family, 2019). Therefore, mathematics educators have begun to recognize the importance of research on multicultural education and conduct research to support the mathematics learning of multicultural students (Bae et al., 2017). In this vein, the purpose of this study is to synthesize previous studies about multicultural mathematics education in South Korea to provide directions for future studies.

Multicultural education has an intricate relation to various areas. Therefore, there are varied ways to synthesize studies on multicultural mathematics education. This study examined previous research focusing on achievements in mathematics, because achievement in mathematics is strongly related to students entering college and their future careers. Moses and Cobb (2001) identified mathematical learning experiences as a civil

rights issue for minority students, describing mathematics as a "gatekeeper course" (p. Ⅶ) to get to first-class economic status. In addition, mathematics can be a tool for minority students to understand complex issues in the real world and develop a sense of agency as a possible actor in society (Gutstein, 2006). Therefore, the goal of this study is to present a review of the literature, exploring various factors that might influence multicultural students' mathematics achievements. Korea is in the stage of embracing multicultural mathematics education, so both Korean and international scholars that experience similar social change with Korea could gain new insight into multicultural mathematics education.

II. THEORETICAL BACKGROUNDS

This study used Opportunity-Propensity (O-P) framework suggested by Byrnes and Miller (2007). According to the model, student achievement is influenced by three factors, including distal, opportunity, and propensity factors (see Figure 1). The distal factor is concerned about antecedent components for student learning, including home background, such as social-economic status (SES), and the students' prior achievements. The opportunity factor is related to the teacher, school, and coursework (e.g., educational materials), which influence students' learning within schools. This factor captures how and to what extent students are given opportunities to acquire mathematics knowledge and skills. The propensity factor is concerned about students' cognitive and non-cognitive components related to a certain subject, such as prerequisite knowledge, aptitude, motivation, and attitude. These propensity conditions explain whether students are capable and willing to take advantage of the learning opportunities given to them.

Scholars have used the O-P framework to understand the development of students' mathematics achievements. For example, Cleary and Kitsantas (2017) examined the associations between motivation and self-regulated learning (propensity factors) with middle school students' mathematics achievements. Zhu and Chiu (2019) investigated the influences of home environments and early numeracy achievement (distal factors) on elementary school students' mathematics achievements. Moreover, concerning opportunity factors, other scholars investigated the effects of the number of mathematics courses and content of the coursework (Davenport et al., 2013) and teacher characteristics and instructional practices (Star et al., 2015) on students' mathematics achievements.

The results of previous studies about multicultural students' mathematics achievements can be explained with the O-P framework (Ladson-Billings, 1995; Usiskin, 2010; Yu, 2022). They reported that mathematics textbooks, teacher instruction, student characteristics and home backgrounds are linked to mathematics learning opportunities of multicultural students. This is due to the fact that while number itself is neutral, teaching mathematics and choosing mathematics content to teach is not neutral (Gutiérrez, 2013; Ladson-Billings, 1995). Mathematics content in textbooks is not a simple collection of neutral facts, but a collection of cultural points of view (Murtadha-Watts & D'Ambrosio, 1997). When mathematics textbook developers select mathematical content from what they regard as pure mathematics (e.g, the properties and structure of abstract objects), the

ways that the content is presented is influenced by socio-cultural content. For example, US mathematics textbooks frequently use American football scores and mortgage rates as a source of word problems, which are infrequently used by other countries (Usiskin, 2010). Similarly, Korean textbook developers use Korean traditional painting, architecture, and design to teach mathematics concepts and procedures.

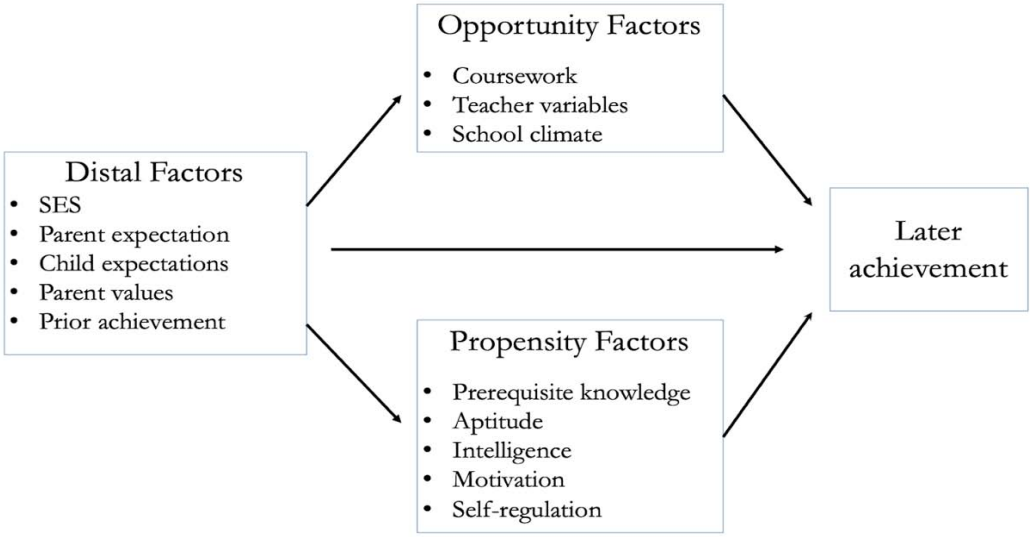

Figure 1. Opportunity-propensity model of achievement (Adapted from Byrnes & Miller, 2007, p. 602).

Moreover, teaching mathematics is partially subjective (Ladson-Billings, 1995). Some mathematical content is noticed or neglected by teachers, leading to different learning opportunities (Schoenfeld, 2011). Additionally, mathematics teachers' perceptions toward multicultural students and education influence their instruction and student learning opportunities because these perceptions formulate how they think and act in the classroom. Rubel (2017) found that high school mathematics teachers' perceptions and beliefs about multicultural students' abilities, culture, and motivation are linked to the ways that teachers execute their instructional practices. Different instructional practices shape the differences in multicultural students' mathematics learning outcomes (Ladson-Billings, 2021; Yu, 2022). For example, Yu (2022) found that when mathematics teachers designed instructions considering students' cultural backgrounds (e.g., using materials and examples related to students' personal experiences), their student's attitudes towards mathematics and mathematics achievement were positively developed. In sum, particular mathematical content, learning methods, and cultural norms are included and prioritized in the mathematics curriculum and teaching, whereas others are excluded or minimized based on the cultural and social expectations of society (Gutiérrez, 2013). Consequently, students who are familiar with these pieces of content easily acquire mathematics knowledge and gain high scores, but that is not the case for multicultural students.

In addition to mathematics textbooks and teachers, multicultural students' distal factors and propensity factors influence their achievements in mathematics. Results of previous studies found that multicultural students with high levels of SES (Ortiz-Franco & Flores, 2001) and motivation (Saw & Chang, 2018) are likely to perform better in mathematics. This is because students from high levels of SES tend to have higher levels of academic aspirations, self-concept, expectations, and classroom involvement than their counterparts (Waxman, Huang, & Padron, 1997). Therefore, we decided to examine previous research focusing on distal, opportunity, and propensity factors to understand the strengths and weaknesses of the current research on multicultural mathematics education.

III. REVIEW METHODS

We searched relevant studies using the following process. First, we retrieved articles in January 2022 through Research Information Sharing Service (RISS) using 'mathematics (수학)' and 'multicultural (다문화)' as our search terms. We did not limit the articles by the year of publication. The initial search resulted in a total of 507 studies. Second, we excluded master and doctoral thesis papers, books, and conference proceedings, which resulted in 130 studies. Third, we reviewed each articles' abstract and findings and excluded articles that studied early childhood and college students, as our focus is Grade 1-12 students. Then, we selected articles that explicitly studied multicultural mathematics education. Finally, twenty-seven studies were selected for review. It is important to note that while some studies explicitly examined a relationship between a certain element (e.g., parent engagement) and multicultural students' mathematics achievements (e.g., Kim & Kim, 2015), other studies analyzed educational environments (e.g., multicultural programs, Kim, & Chang, 2016) and teaching resources (e.g., mathematics curriculum, Kim, 2017), which might implicitly influence their achievements. Therefore, the latter studies did not investigate how those elements are directly related to multicultural students' mathematics achievements. However, we included those studies based on the recommendation of previous studies (Byrnes, 2020; Cleary & Kitsantas, 2017; Davenport et al., 2013; Star et al., 2015; Zhu & Chiu, 2019).

The two authors of this study individually read the full texts of the selected twenty-seven articles and coded them into one of three domains, including distal, opportunity, and propensity factors using the O-P model (Byrnes & Miller, 2007). In this process, we revised the O-P framework and created new codes, because the previous codes were not enough to classify the collected articles. For example, Cho and Lee (2010) developed mathematics tests for multicultural students and Ham, Ku, and Cha (2014) examined the influence of educational policy on multicultural student achievement, which was not suggested in the O-P model. Figure 2 shows the revised framework used for the study. The revised O-P model was quite similar to the previous ones. However, opportunity factors had more components than the previous model, such as developing multicultural mathematics programs, Korean language support, educational policy, and test development. For example, articles in 'Korean language support' studied developing

educational materials and teaching strategies to help multicultural students with emergent Korean language proficiency to learn mathematics more easily.

We allowed simultaneous coding, where a single study was coded with multiple codes (Saldaňa, 2009) to more clearly present the research goals of each study. For example, a study examining parental engagement and teacher variables was coded into 'distal factors' and 'opportunity factors' (Kim & Kim, 2015). We compared our initial coding results and resolved any discrepancies through discussion which led to 100% agreement of the final coding result.

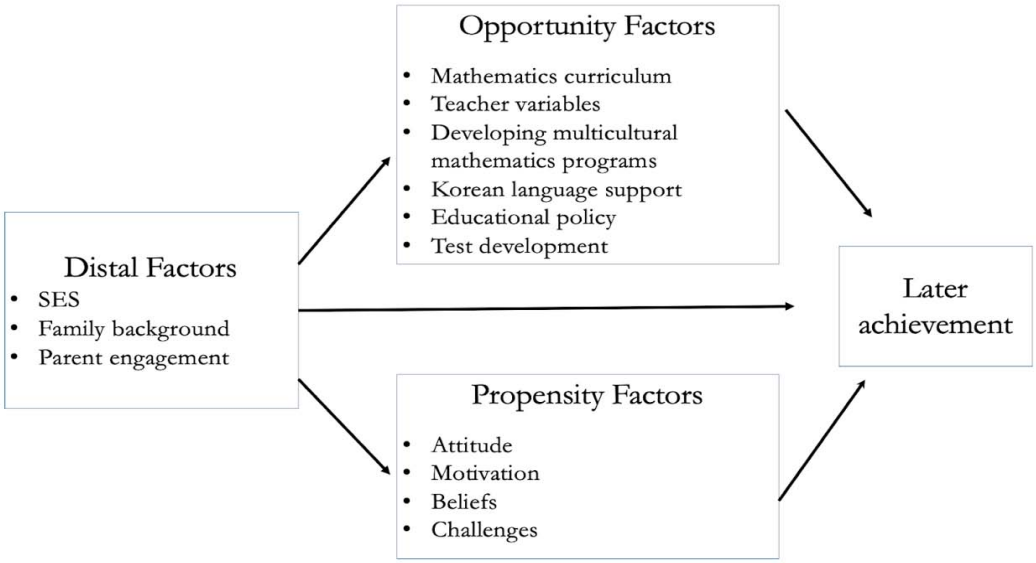

Figure 2. Revised O-P model for the study

IV. FINDINGS

This section provides an analysis of a selected twenty-seven articles (see Table 1 and Appendix). The year that the first article was published is 2010 (Cho & Lee, 2010; Choi & Jeong, 2010). This result indicated that the attention to multicultural education in the community of Korean mathematics education scholars was pretty recent. Seven articles (25.9%) directly measured the effect of various components (e.g., parent or teachers) on multicultural students' mathematics achievements (Choi-Koh, 2013; Choi & Chang, 2019; Ham et al., 2014; Kim, 2021; Kim & Ko, 2021; Youn & Kang, 2019). The other twenty articles (74.1%) did not specifically examine the direct association between them. Instead, they analyzed other components (e.g., mathematics textbooks and teacher variables) which may help or impede the mathematics achievement of multicultural students. When applied the revised O-P model, the category of opportunity factors took the largest proportion (n = 19, 70.4%), followed by propensity factors (n = 4, 14.8%) and

distal factors (n = 3, 11.1%). One article studied (Kim & Kim, 2015) both distal and opportunity factors (n = 1, 3.7%). In the following, we discussed articles in the individual factors.

Table 1. Scholarly research on multicultural mathematics education

Factor N (%)	Components	Citation	Studying MA
Distal factors 3 (11.1%)	Home background	Choi-Koh (2013) Youn and Kang (2019)	O O
	Parent SES	Kim and Ko (2021)	O
Distal & opportunity factors 1 (3.7%)	Parent engagement Teacher variable	Kim and Kim (2015)	X
Opportunity factors 19 (70.4 %)	Mathematics curriculum	Bae et al. (2017) Cho (2011) Cho (2018) Hwang, Cho, and Albert (2020) Jeong, Ju, and Song (2014) Kim (2017) Nam, Oh, and Choi (2020)	X X X X X X X
	Teacher variable	Oh (2013) Song, Noh, and Ju (2011) Song, Noh, and Ju (2013)	X X X
	Developing multicultural mathematics programs	Choi and Jeong (2010) Kim and Chang (2016) Park (2010) Song and Ju (2021)	X X X X
	Korean language support	Choi and Chang (2019) Oh (2021) Park and Noh (2017)	O X X
	Educational policy	Ham et al. (2014)	O
	Test development	Cho and Lee (2010)	O
Propensity factors 4 (14.8%)	Attitude	Kim (2021)	O
	Motivation	Cho and Hwang (2019)	X
	Belief	Do (2021)	X
	Challenges	Jang and Ko (2009)	X

Note. Studying MA indicated an article explicitly examined student mathematics achievement

Distal Factors

Studies examining distal factors investigated the influence of the home environments (e.g., parent support, SES, and engagement) on multicultural students' mathematics achievements (Choi-Koh, 2013; Kim & Kim, 2015; Kim & Ko, 2021; Youn & Kang, 2019). All these articles focused on elementary school students. Three articles found that home environments are positively associated with student mathematics achievement. For example, Youn and Kang (2019) examined mathematics achievement gaps between multicultural students and Korean-born students and found that the differences in the parents' educational support lead to their achievement gaps. Thus, they claimed that parents' educational support should be enhanced to increase the mathematics achievement of multicultural students. However, one article showed a different finding. Using the longitudinal dataset, Kim and Ko (2021) found that the income of the household and the education level of the parents did not predict the mathematics achievement of multicultural students. These inconsistent findings indicated the need for additional studies.

Opportunity Factors

Most of the research among our data focused on an opportunity factor – culturally defined contexts where multicultural students are presented with learning mathematics in schools. Six components were derived: (a) mathematics curriculum, (b) teacher variable, (c) developing multicultural mathematics programs, (d) Korean language support, (e) educational policy, and (f) test development. First, seven articles studied the mathematics curriculum. Note that we used curriculum to refer to various instructional materials, including textbooks, student workbooks, and standards (Remillard & Heck, 2014). Five articles examined the characteristics of the elementary school mathematics curriculum (e.g., Cho, 2018) and the other two were about middle school curriculum (e.g., Choi & Jeong, 2010). There was no study examining the high school mathematics curriculum. Moreover, five studies examined only Korean mathematic textbooks (e.g., Cho, 2018), whereas two studies executed a cross-country textbook analysis (e.g., Cho, 2011).

Most studies reported that the Korean mathematics curriculum lacked multicultural education content. For example, Cho (2011) compared the illustrations in Korean elementary mathematics textbooks with Finnish elementary mathematics textbooks. The study found that the illustrations of the Korean textbooks are relatively homogeneous regarding characters' appearance, race, and hair color compared to the Finnish ones. Furthermore, the characters' names in textbooks were also quite limited in Korean textbooks, which only included popular last names in Korea, such as 'Kim.' However, Finnish textbooks include more diverse names. These findings indicated the necessity of revising Korean mathematics textbooks to include deliberate representations of multicultural education content (Bae et al., 2017). From a different perspective, Nam, Oh, & Choi (2020) compared Korean and Chinese elementary mathematics textbooks and found differences in teaching methods, content, vocabulary, and chapter arrangement which might lead to low mathematics achievements in Chinese immigrant students.

Second, regarding teacher variables (n = 4), some articles examined mathematics teachers' perceptions of multiculturalism and their multicultural teaching competency (Oh, 2013; Song, Noh, & Ju, 2013). Other articles focused on teaching practice (e.g., pedagogical approaches) in mathematics classrooms (Kim & Kim, 2015; Song, Noh, & Ju, 2011). Three articles studied in-service teachers (Kim & Kim, 2015; Song et al., 2011, 2013) and one article examined pre-service teachers (Oh, 2013). For example, Oh (2013) examined preservice middle school mathematics teachers' experiences and teaching efficacy in multicultural education, attitudes toward multicultural education, and stereotypes about multicultural students. Moreover, Song et al. (2011) studied instructional practices of elementary and middle school teachers in mathematics classrooms from the multicultural education perspectives. Interestingly, none of them measured the direct effect of teacher variables on students' achievements in mathematics.

Third, four articles studied the mathematical program for multicultural students. Three measured the effect of mathematics programs that were designed to enhance students' openness and acceptability of multiculturalism (Choi & Jeong, 2010; Kim & Chang, 2016; Park, 2010). The target population of these articles was Korean-born students. For example, Kim and Chang (2016) created a program for sixth-graders comprised of twenty lessons about ratio and proportional distribution. This program reflected the perspectives of ethnomathematics (i.e., mathematical thinking and concepts that differ by communities and cultures) and critical mathematics theory (i.e, mathematics serves as a tool for identifying and analyzing features of society). Based on the results, the authors claimed that multicultural mathematics programs could enhance student perception toward multiculturalism. Compared to the three articles focusing on students, Song and Ju's (2021) study examined teachers' capacity of designing multicultural mathematics lessons.

Fourth, three articles studied Korean language support for multicultural students. Two articles focused on elementary school students (Choi & Chang, 2019; Park & Noh, 2017), and the other one studied middle school students (Oh, 2021). Park and Noh (2017) analyzed word problems in the 3rd-grade mathematics textbook and suggested teaching strategies to enhance both Korean language and problem-solving abilities for multicultural students, which consisted of enhancing basic calculation capability, linguistic adaptability, and word problem-solving ability. Similarly, Choi and Chang (2019) proposed the model of sheltered instruction observation protocol for multicultural students with weak Korean language ability.

Fifth, one article examined the relationship between educational policy and student achievement (Ham et al., 2014). Using the Trends in the International Mathematics and Science Study 2011 dataset, they explored the effect of multicultural curriculum policies on middle school multicultural student mathematics achievement across thirty-one countries. The study found that when countries have positive curriculum policies for minorities, multicultural students are likely to have high levels of mathematics engagement and achievement.

Sixth, one study developed a mathematics diagnostic test for low-grade elementary multicultural students (Cho & Lee, 2010). Based on the test results, they

reported that multicultural students with low Korean language ability showed lower mathematics achievement in word problems and high-demanding items than other Korean-born students. These results indicated the influence of Korean language proficiency in mathematics achievement.

Propensity Factors

Four articles studied the propensity factors, including multicultural students' attitudes towards mathematics (Kim, 2021), motivation in mathematics (Cho & Hwang, 2019), beliefs towards mathematics (Do, 2021), and the challenges that they encountered in studying mathematics (Jang & Ko, 2009). All articles analyzed elementary or middle school students. Cho and Hwang (2019) employed a three-year longitudinal case study to track the changes in mathematics motivation of six elementary school students from elementary school to middle school. They demonstrated a variety of contextual factors, including support from teachers, parents, and peers' performances, which influenced their motivation towards mathematics. For example, if multicultural students felt that their mathematics performance was good enough in competing with Korean-born students, they were likely to keep being motivated to study mathematics. This finding is similar to Do's study (2021) which found that multicultural students tended to believe that success in mathematics can only be possible when their mathematics achievements were already high. However, Korean-born students had more positive beliefs in mathematics learning, believing that they could resolve any conflict in learning mathematics.

V. DISCUSSION AND IMPLICATIONS

Given the increasing attention toward multicultural education, this study summarized and synthesized previous articles on multicultural mathematics education. The framework of this study was built on the O-P framework (Byrnes & Miller, 2007) to classify twenty-seven articles into three domains (i.e., distal, opportunity, and propensity factors). We revised the framework to include diverse components of the domains that had emerged from the articles. As shown in Table 2, the distal factor includes SES, family background, and parent engagement. The opportunity factor covered the topics that influence students' learning at schools, including mathematics curriculum, teacher variables, developing multicultural mathematics programs, Korean language support, educational policy, and test development. Additionally, the propensity factors contained articles about students' attitudes, motivation, beliefs, and challenges.

We found that of the twenty-seven articles, only seven articles (25.9%) specifically examined multicultural students' achievements in mathematics. The other twenty articles (74.1%) examined other components (e.g., mathematics curriculum) which may help or impede the mathematics achievement of multicultural students. Moreover, opportunity factors took the largest proportion (n = 19, 70.4%), followed by propensity factors (n = 4, 14.8%) and distal factors (n = 3, 11.1%). More specifically, most articles related to

mathematics curriculum (n = 7), teacher variables (n = 4), developing multicultural mathematics programs (n= 4), and Korean language support (n = 3). These results implied that the mathematics education scholars were more interested in how the role of teachers, curriculum, and schools play out in multicultural students' mathematics learning than students' innate traits (e.g., motivation and attitudes) and family backgrounds.

Moreover, compared to the original O-P model (Byrnes & Miller, 2007), no article was studying parental expectation and values, student expectation and prior achievement, prerequisite knowledge, intelligence, and self-regulation. This result was considered reasonable because Byrnes and Miller (2007) developed the model based on student achievement, whereas this study developed a model to synthesize the articles about multicultural mathematics education. However, the difference in the components between Byrnes and Miller's (2007) study and our study helped us to identify the directions for future research.

Based on the results of the study, we suggested the following studies. First, studies examining student prior achievement (distal factor) and prerequisite knowledge (propensity factor) are required. Recent studies examining longitudinal data have reported a positive relationship between student prior achievement and their mathematics achievement. For example, in a study examining Latino students' mathematics achievement growth trajectories, Hong and You (2012) found that students are likely to sustain their initial mathematics achievement over time; the higher achievers continuously showed higher performances. Other studies examining Hong-Kong (Mok, McInerney, Zhu, & Or, 2015) and German students (Salaschek, Zeuch, & Souvignier, 2014) reported similar findings. Moreover, Caviola, Colling, Mammarella, and Szűcs (2020) reported a positive association between students' early cognitive skills and later mathematics achievement. Therefore, studies examining the influence of multicultural students' prior achievement and prerequisite knowledge could enhance our understanding of the mathematics achievement growth trajectories of multicultural students.

Second, studies directly examining multicultural students' mathematics achievements should be implemented more. Some studies examined teaching strategies (e.g., Park & Noh, 2017) and others examined multicultural content in mathematics textbooks (e.g., Bae et al., 2017). However, we could not ensure their influences on multicultural student achievement, because the associations might vary according to student characteristics, such as their Korean language proficiency and previous achievement. For example, while student-centered instructional practices are generally beneficial for student mathematics achievement, some studies have reported a negative association between them for the low-performing students (Andersen & Andersen, 2017; Eriksson, Helenius, & Ryve, 2019). Therefore, we need more thorough studies to understand what components (or approaches) could help each group of multicultural students' mathematics achievement.

Third, more studies should be conducted targeting high school students, teachers, and curriculum. Of the twenty-seven articles, only two articles examined high school students and teachers. This could be due to the fact that high school education is focusing on preparing for college entrance tests, so it is challenging to recruit participants. However,

given the influence of high school mathematics achievement on students' college entrance and future careers (Moses & Cobb, 2001), we need more empirical studies to shed light on how to support multicultural students' mathematics achievement.

Fourth, we need more studies examining students' innate traits and family backgrounds. As validated in our review, most articles have focused on school-related components. Multicultural student mathematics achievement is not only influenced by opportunity factors but also distal and propensity factors (Cho & Hwang, 2019). Therefore, future studies should examine how those factors influence mathematics learning of multicultural students.

In this study, we have presented the results of a literate review of multicultural mathematics education. We believe that ongoing research in this field could deepen our understanding of multicultural mathematics education and help mathematics educators understand how to support increased mathematics achievement of multicultural students.

References

Andersen, I. G., & Andersen, S. C. (2017). Student-centered instruction and academic achievement: Linking mechanisms of educational inequality to schools' instructional strategy. *British Journal of Sociology of Education, 38*(4), 533-550.

Bae, M., Cho, H., & Kwon, O. (2017). Elementary mathematics textbook analysis from multicultural mathematics education perspective. *Journal of Learner-Centered Curriculum and Instruction, 17*(17), 613-633.

Byrnes, J. (2020). The potential utility of an opportunity-propensity framework for understanding individual and group differences in developmental outcomes: A retrospective progress report. *Developmental Review, 56*, 100911.

Byrnes, J., & Miller, D. (2007). The relative importance of predictors of math and science achievement: An opportunity–propensity analysis. *Contemporary Educational Psychology, 32*(4), 599-629.

Caviola, S., Colling, L., Mammarella, I., & Szűcs, D. (2020). Predictors of mathematics in primary school: Magnitude comparison, verbal and spatial working memory measures. *Developmental Science, 23*(6), e12957.

Cho, E., & Hwang, S. (2019). Exploring changes in multi-ethnic students' mathematics achievement motivation: A longitudinal study using expectancy-value theory. *The Mathematical Education, 58*(1), 101-120.

Cho, M. (2011). Multicultural content analysis of the 2007 revised mathematics textbooks: South Korea and Finland's illustrations of math textbooks, focusing on the comparison. *The Korean Journal of Multicultural Education, 2*(1), 57-78.

Cho, S. (2018). Multicultural education shown in elementary school mathematics textbook based on 2015 revised curriculum. *Education of Primary School Mathematics, 21*(1), 19-37.

Cho, Y., & Lee, O. (2010). An analysis of the results of a mathematics diagnostic test taken by multicultural Koreans in their first or second year of elementary school.

Journal of Educational Research in Mathematics, 20(2), 103-119.

Choi, C., & Jeong, E. (2010). Using cooperative learning in mathematics programs for multicultural education development and effect. *The Korean Journal of Multicultural Education, 1*(3), 115-132.

Choi, H., & Chang, H. (2019). A study on teaching methods of mathematics using SIOP model for KLLs. *Journal of Elementary Mathematics Education in Korea, 23*(3), 305-321.

Choi-Koh, S. S. (2013). The characteristics of multi-cultural students, North Korean defectors, and students of low-SES on the mathematical achievement test. *The Korea Journal of Learning Disabilities, 10*(2), 1-26.

Cleary, T., & Kitsantas, A. (2017). Motivation and self-regulated learning influences on middle school mathematics achievement. *School Psychology Review, 46*(1), 88-107.

Davenport, E. C., Davison, M. L., Wu, Y.-C., Kim, S.-K., Kuang, H., Kwak, N. … Ayodele, A. (2013). Number of courses, content of courses, and prior achievement related to ethnic achievement gaps in mathematics. *Journal of Educational Leadership in Action, 2*(1), 1-35.

Do, J. (2021). An analysis of characteristics of the perception for mathematics learning of Korean language learners in 6th grade of elementary school. *The Mathematical Education, 60*(4), 529-542.

Eriksson, K., Helenius, O., & Ryve, A. (2019). Using TIMSS items to evaluate the effectiveness of different instructional practices. *Instructional Science, 47*(1), 1-18.

Gutiérrez, R. (2002). Enabling the practice of mathematics teachers in context: Toward a new equity research agenda. *Mathematical Thinking and Learning, 4*(2), 145-187.

Gutiérrez, R. (2013). The sociopolitical turn in mathematics education. *Journal for Research in Mathematics Education, 44*(1), 37-68.

Gutstein, E. (2006). *Reading and writing the world with mathematics: Toward a pedagogy for social justice.* Routledge.

Ham, S., Ku, H., & Cha, Y. (2014). The effect of multicultural education policy on ethno-linguistic minority students' academic enjoyment and performance: Evidence from TIMSS 2011. *Multicultural Education Studies, 7*(4), 123-142.

Hong, S., & You, S. (2012). Understanding Latino children's heterogeneous academic growth trajectories: Latent growth mixture modeling approach. *The Journal of Educational Research, 105*(4), 235-244.

Hwang, S., Cho, E., & Albert, L. R. (2020). Examining mathematics teachers' perception toward multicultural education: Teachers' noticing of multicultural contents in mathematics textbooks. *Research in Mathematical Education, 23*(2), 93-111.

Jang, Y., & Ko, S. (2009). A case study on the instructional dimensions in teaching mathematics to the elementary school students from multicultural backgrounds. *The Mathematical Education, 48*(4), 419-442.

Jeong, S., Ju, M., & Song, R. (2014). A critical analysis of the didactic use of historical mathematics seventh grade mathematics textbooks. *Journal of Research in Curriculum Instruction, 18*(2), 441-470.

Jurdak, M. (2009). *Toward equity in quality in mathematics education*. Springer.

Kim, H. (2021). A case study on the effect of the primary concept of mathematics on the formation of schema on the ratio, proportion, proportional expression, and percentage of multicultural students in the sixth grade of elementary school. *Journal of Learner-Centered Curriculum and Instruction, 21*(4), 551-577.

Kim, H., & Ko, H. (2021). A classification analysis of students from multicultural families based on their mathematics achievement over time. *The Mathematical Education, 60*(2), 191-207.

Kim, J. (2017). A study on the analysis mathematic curriculum for development of instrument for multicultural classroom in mathematics lesson of middle school. *The Journal of Curriculum and Instruction Studies, 10*(1), 83-93.

Kim, J., & Chang, I. (2016). A study on the effects of multicultural programs based on ethnomathematics and critical mathematics on multicultural acceptability. *The Journal of Curriculum Studies, 34*(4), 151-169.

Kim, S., & Kim, Y. (2015). Research on environmental factors that affect mathematics learning of students in multicultural families. *East Asian Mathematics Journal, 31*(2), 245-273.

Korean Educational Development Institution [KEDI]. (2021). *Korean educational statistics service report*. Retrieved from: https://kess.kedi.re.kr/index

Ladson-Billings, G. (1995). Making mathematics meaningful in multicultural contexts. In W. G. Secada, E. Fennema, & L. B. Adajian (Eds.), *New directions for equity in mathematics education* (pp. 126-145). Cambridge University Press.

Ladson-Billings, G. (2021). Does that count? How mathematics education can support justice-focused anti-racist teaching and learning. *Journal of Urban Mathematics Education, 14*(1B), 1-5.

Ministry of Gender Equality & Family. (2019). *An analysis on the national survey on multicultural families 2019*. Author.

Mok, M. M., McInerney, D. M., Zhu, J., & Or, A. (2015). Growth trajectories of mathematics achievement: Longitudinal tracking of student academic progress. *British Journal of Educational Psychology, 85*(2), 154-171.

Moses, R., & Cobb, C. (2001). *Radical equations: Math literacy and civil rights*. Beacon Press.

Murtadha-Watts, K., & D'Ambrosio, B. (1997). A convergence of transformative multicultural and mathematics instruction: Dilemmas of group deliberations for curriculum change. *Journal for Research in Mathematics Education, 28*(6), 767-782.

Nam, M., Oh, H., & Choi, K. (2020). Analysis of the causes of learning difficulties for middle-entry students with a focus on the comparison between Korean and Chinese curriculum on elementary school mathematics. *Multicultural Education Studies, 13*(2), 21-55.

National Council of Teachers of Mathematics [NCTM]. (2000). *Principles and standards for school mathematics*. Author.

National Council of Teachers of Mathematics [NCTM]. (2014). *Principles to actions: Ensuring mathematical success for all*. Author.

Oh, I. (2021). A case of developing a middle school mathematics workbook for multicultural learners in Korea. *Homo Migrans, 25*, 31-55.

Oh, J. (2013). The study of multicultural education for preservice teachers in Gangwon-do who major in mathematics education. *The Mathematical Education, 52*(3), 379-398.

Ortiz-Franco, L., & Flores, W. (2001). Sociocultural considerations and Latino mathematics achievement: A critical review. In B. Atweh, H. Forgasz, & B. Nebres (Eds.), *Sociocultural research on mathematics education: An international perspective* (pp. 233–253). Lawrence Erlbaum Associates, Inc.

Park, B. (2010). The study of development and effect of multicultural education teaching learning programs of mathematics. *The Korean Journal of Multicultural Education, 1*(3), 31-65.

Park, J., & Noh, J. (2017). A teaching method for students in multi-cultural family to improve mathematical performance capability with math word problems. *The Studies of Korean Language and Literature, 59*, 351-382.

Remillard, J., & Heck, D. (2014). Conceptualizing the curriculum enactment process in mathematics education. *ZDM, 46*(5), 705-718.

Rubel, L. (2017). Equity-directed instructional practices: Beyond the dominant perspective. *Journal of Urban Mathematics Education, 10*(2), 66-105.

Salaschek, M., Zeuch, N., & Souvignier, E. (2014). Mathematics growth trajectories in first grade: Cumulative vs. compensatory patterns and the role of number sense. *Learning and Individual Differences, 35*, 103-112.

Saldaňa, J. (2009). *The coding manual for qualitative researchers*. SAGE Publications.

Saw, G., & Chang, C. (2018). Cross-lagged models of mathematics achievement and motivational factors among Hispanic and non-Hispanic high school students. *Hispanic Journal of Behavioral Sciences, 40*(2), 240-256.

Schoenfeld, A. (2011). Noticing matters. A lot. Now what? In M. Sherin, R. Phillip, & V. Jacobs (Eds.), *Mathematics teacher noticing: Seeing through teachers' eyes* (pp. 223–238). Routledge.

Solomon, Y., Hough, S., & Gough, S. (2021). The role of appropriation in guided reinvention: Establishing and preserving devolved authority with low-attaining students. *Educational Studies in Mathematics, 106*(2), 171-188.

Song, R., & Ju, M. (2021). An analysis of teachers' pedagogical design capacity for multicultural mathematics education. *Journal of Educational Research in Mathematics, 31*(1), 83-107.

Song, R., Noh, S., & Ju, M. (2011). investigation of the teaching practice in mathematics classroom with immigrant students. *School Mathematics, 13*(1), 37-63.

Song, R., Noh, S., & Ju, M. (2013). An analysis of Korean mathematics teacher's multicultural competence: Implications for multicultural mathematics teacher education. *Journal of Educational Research in Mathematics, 23*(3), 313-333.

Star, J., Newton, K., Pollack, C., Kokka, K., Rittle-Johnson, B., & Durkin, K. (2015). Student, teacher, and instructional characteristics related to students' gains in flexibility. *Contemporary Educational Psychology, 41*, 198-208.

Usiskin, Z. (2010). The current state of the school mathematics curriculum. In B. J. Reys, R. E. Reys, & R. Rheta (Eds.), *Mathematics curriculum: Issues, trends, and future directions* (pp. 25–39). National Council for Teachers of Mathematics.

Waxman, H., Huang, S., & Padron, Y. (1997). Motivation and learning environment differences between resilient and nonresilient Latino middle school students. *Hispanic Journal of Behavioral Sciences, 19*(2), 137-155.

Youn, M., & Kang, C. (2019). Educational inequality of immigrant students: Examining the influence of socioeconomic status on achievement gap between immigrant and native students. *Multicultural Education Studies, 12*(4), 57-77.

Yu, E. (2022). The impact of culturally inclusive pedagogy on student achievement in a multicultural urban school setting. *Urban Education, 57*(1), 135-153.

Zhu, J., & Chiu, M. (2019). Early home numeracy activities and later mathematics achievement: Early numeracy, interest, and self-efficacy as mediators. *Educational Studies in Mathematics, 102*(2), 173-191.

Appendix. Brief summary of each study

Domain	Citation(s)	Information of the study
Distal factors	Choi-Koh (2013)	Family background - Elementary school (Grade 1-6) - Low income family vs. Multicultural family vs North Korean refugee family
	Kim and Ko (2021)	Parent SES - Elementary school (Grade 1-6)
	Youn and Kang (2019)	Parent SES - Elementary school (Grade 4), middle school (Grade 7), and high school (Grade 10)
Distal & opportunity factors	Kim and Kim (2015)	Parent engagement - Elementary school (Grade 1-6) and middle school (Grade 7) Teacher variables (Teacher interaction with students)
Opportunity factors	Bae et al. (2017)	Mathematics textbook - Elementary school (Grade 1-6) - 2009 revised Korean elementary school mathematics curriculum
	Cho (2011)	Mathematics textbook - Elementary school - Grade 1-4 (Korean textbook) & Grade 1-6 (Finnish textbook) - 2007 revised Korean elementary school mathematics curriculum
	Cho (2018)	Mathematics textbook - Elementary school (Grade 1-2) - 2015 revised Korean elementary school mathematics curriculum
	Choi and Chang (2019)	Korean language support - Elementary school (Grade 5) - Geometry (Congruence and symmetry) - The effect of Korean language proficiency on mathematical communication and mistakes
	Choi and Jeong (2010)	Multicultural mathematics lesson - High school (Grade 10 and 11)
	Ham et al. (2014)	Educational policy - Middle school (Grade 8)
	Hwang et al. (2020)	Teacher variables - Elementary school teachers - Teacher noticing of multicultural contents
	Jeong et al. (2014)	Mathematics textbook - Middle school (Grade 7)

	- 2009 revised Korean middle school mathematics curriculum
Kim (2017)	Mathematics textbook - Middle school (Grade 8)
Kim and Chang (2016)	Multicultural mathematics lesson - Elementary school (Grade 6)
Nam et al. (2020)	Mathematics textbook - Grade 1-6 (Korean textbook) & Grade 1-6 (Chinese textbook) - 2015 revised Korean elementary school mathematics curriculum & 2011 Chinese elementary school mathematics curriculum
Oh (2013)	Teacher variables - Middle school preservice teachers - Preservice teachers' experience of multiculturalism, multicultural efficacy, multicultural understanding, and multicultural sensitivity
Oh (2021)	Korean language support - Middle school (Grade 7) - Supplementary curricular materials
Park (2010)	Multicultural mathematics lesson - Middle school (Grade 8) - Awareness about and prejudices against multiculture
Park and Noh (2017)	Korean language support - Elementary school (grade 3) - The use of mathematics word problems
Song and Ju (2021)	Multicultural mathematics lesson - Elementary, middle, and high school teachers (Grades are not specified) - Teacher's capacity of design multicultural mathematics lesson
Song et al. (2011)	Teacher variables - Elementary school teachers (Grade 5-6) and middle school teachers (Grade 7) - Teaching practice in mathematics classroom with multicultural students
Song et al. (2013)	Teacher variables - Elementary and middle school teachers (Grades are not specified) - Teacher's multicultural competency
Cho and Lee (2010)	Test development - Elementary School (Grade 1-2) - Mathematics diagnostic test

Propensity factors	Cho and Hwang (2019)	Motivation - Elementary school and middle school (Grade 6 to Grade 8) - Mathematics academic motivation
	Do (2021)	Belief - Elementary school (Grade 6) - Perception of mathematics learning of multicultural students
	Kim (2021)	Attitude - Elementary school (Grade 6) - The effect of the primary concept of mathematics on the formation of schema
	Jang and Ko (2009)	Challenges - Elementary school (Grade 2) - Challenges in solving mathematics problems in classroom

Note. MA indicates studies explicitly examining multicultural student mathematics achievement