RESEARCH REVIEW

Understanding a Mathematics Teacher Community through a Computational Text Analysis: Review of *Changes in Mathematics Pedagogical Lexicons* by Lee & Kim (2022)

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Abstract

Mathematics educators have emphasized the importance of language use in mathematics education. However, previous studies have predominantly focused on the spoken language used in mathematics classrooms, which provides limited information on the written language used by mathematics teachers. The written language reflects the characteristics of the teacher community and social, cultural, and political contexts. Moreover, the written language affects teachers' instructional practices and their students' mathematics learning experiences. Therefore, this study aims to review a study conducted by Lee and Kim (2022) investigating changes in mathematics teachers' pedagogical lexicons.

Keywords written-language, lexicon, mathematics teacher, teacher community

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I. OPENING REMARKS

The majority of previous studies on language in mathematics education have focused on exploring the oral language used by teachers when teaching and learning mathematics. One example of this is the International Classroom Lexicon Project, which involved mathematics education researchers from 10 countries (Cho & Kim, 2018). As part of this project, the researchers analyzed video recordings of mathematics teacher instruction and identified eight types of mathematical lexicons (see Table 1). Although this project provided valuable insights into the mathematical lexicons used by mathematics teachers, it focused solely on verbal and non-verbal language.

In this vein, Lee and Kim (2022) examined the written language collected from the mathematics teacher practitioner journal and compared their findings with previous studies focusing on mathematics teachers' verbal language. In particular, Lee and Kim's study examined the pedagogical lexicons used in "*Mathematics and Education*", translated from "수학과 교육", a practitioner journal issued by the Korean Society of Teachers of Mathematics, and analyzed texts in the journal to explore the interests and values of the Korean mathematics teacher community. Furthermore, they implemented a text-mining method such as a word frequency analysis and applied Word2Vec (type of text-mining method) to classify the frequency of the lexicons into eight categories.

More specifically, Lee and Kim's study analyzed the 58 issues of *Mathematics and Education* published from 2013 to 2022, which consisted of approximately 5,500 pages. The most used lexicons were related to "Mathematics teaching and learning activity" (category 2, 29.4%), followed by "Teaching and learning activity" (category 1, 26.5%), "Assessment" (category 3, 11.8%), "Lesson improvement" (category 7, 8.8%), "Lesson format" (category 4, 7.3%), "Lesson structure" (category 5, 5.9%), "Others" (category 8, 5.9%), and "Preparation of a lesson" (category 6, 4.4%). The lexicons regarding mathematics classroom activities and assessments (categories 1, 2, and 3) account for 67.7% of all pedagogical lexicons studied. These results were similar to the findings of Cho and Kim (2018), who examined the types and frequency of verbal language used in mathematics classrooms (Table 1).

The authors divided the 10 years into the following three time periods: period 1 (2013–2015), period 2 (2016–2019), and period 3 (2020–2022). This periodization was based on major social and educational events that shaped the course of history in mathematics education. The authors provided an interpretation of why certain lexicons received more attention or not in the Korean mathematics teacher community. Period 1 spanned from the beginning of the 4th industrial revolution in Korean society (2013) to the initiation of the 2015 revised mathematics curriculum (2015). It is worth noting that Korea has only one type of nationwide curriculum, and teachers are required to follow it when designing and implementing lessons.

The second period spanned from the implementation of the 2015 revised curriculum to before the COVID-19 pandemic (2016–2019). The third period covered the outbreak of COVID-19 up to the year 2022 when the authors completed their data collection (2020–2022). The proportion of each category across the three-time period is

presented in Table 2, similar to the findings in Table 1. Categories 1, 2, and 3 were consistently discussed in the practitioner journal, indicating that overall Korean mathematics teachers had similar interests regardless of time span. This result suggests that Korean mathematics teachers consistently place considerable importance on these topics, including teaching and learning activity, mathematics teaching and learning activity, and assessment despite the societal changes.

Table 1. Categories and proportion of pedagogical lexicons

Category	Name	Examples	Lee & Kim (2022) %	Cho & Kim (2018) %
1	Teaching and learning activity	Problem solving, Assessment, Question, Worksheets	26.5	34.3
2	Mathematics teaching and learning activity	Recalling previous lesson, Discovery, Reasoning, Coding, GeoGebra, AlgeoMath, Software	29.4	17.1
3	Assessment	Engagement, Test, Evaluation, Performative assessment, Formative assessment, Mid-term test, final tests, Essay exam	11.8	14.3
4	Lesson format	Multimedia lesson, Lesson with technology and technological devices, Online learning, Remote learning	7.3	8.6
5	Lesson structure	Classroom presentation, Introduction, Lesson development, Warp up, Group work	5.9	6.7
6	Preparation of a lesson	Lesson preparation	4.4	2.9
7	Lesson improvement	Professional development, Teacher learning community, Lesson study	8.8	7.6
8	Others	Alignment between curriculum and classroom evaluation, Artificial intelligence, Curriculum	5.9	8.5
Total			100	100

Note. Lee and Kim (2022) calculated the proportion by dividing the frequency of a category by the total frequency, whereas Cho and Kim (2018) calculated the proportion by dividing the number of lexicons of a category by the total number of lexicons. Moreover, Lee and Kim (2022) examined the written language collected from the mathematics teacher practitioner journal, whereas Cho and Kim (2018) examined the verbal language used in mathematics classrooms.

Meanwhile, category 4, "Lesson format," surged in Period 3 (from 0.41% in Period 2 to 3.07% in Period 3). The lexicons included in Category 4 were multimedia lessons,

lessons with technology and technological devices, online learning, remote learning, etc. Lee and Kim (2022) attributed this surge to the influence of COVID-19 and its cascading effect on education where schools had mandated closure and instructions were shifted to remote and online environments. This finding suggests that global events can have a direct and indirect impact on mathematics education at a national level. Despite these changes, Korean mathematics teachers still focused on the lexicons related to teacher instruction, mathematics classroom activities, and assessment-oriented classroom practices.

Table 2. Proportion of lexicons usage by individual category over time

Category	Name	Period		
		2013–2015 (%)	2016–2019 (%)	2020–2022 (%)
1	Teaching and learning activity	35.66	34.05	33.62
2	Mathematics teaching and learning activity	33.71	30.91	30.78
3	Assessment	24.20	26.41	20.39
4	Lesson format	0.37	0.41	3.07
5	Lesson structure	3.03	4.50	4.12
6	Preparation of a lesson	0.92	0.77	0.34
7	Lesson improvement	0.25	0.39	0.74
8	Others	1.86	2.56	6.94
Total		100	100	100

The authors also conducted a linear regression analysis to examine the proportional change of each lexicon and found that ''assessment,'' ''curriculum,'' and ''discovery'' showed the largest increment over time. Combining the findings with the results presented in Tables 1 and 2, it can be interpreted that Korean mathematics teachers are interested in discussing specific assessment methods, curriculum, assessment based on curriculum, mathematics teaching, and learning, along with mathematical discovery and assessing students' mathematical discovery. This finding is consistent with another study that confirmed Korean teachers' focus on high-stakes assessments and college entrance exams (Kwon et al., 2017).

However, this finding differs from previous studies that analyzed the topics or issues in UK mathematics teacher professional journals (Foster & Inglis, 2019). Foster and Inglis reported that UK mathematics teachers decreased their interest in assessment-related topics over time. Similarly, Dobie and Sherin (2021) examined pedagogical lexicons presented in US mathematics teacher practitioner journals and reported a similar trend. This contrast can be understood through Korea's local history, sociocultural norms, and expectations of parents and students on student mathematics achievement.

The highly competitive college entrance system in Korea causes assessment-oriented teaching and learning of mathematics (Ro, 2019), which places a considerable

burden and stress on mathematics teachers to mold their students into good test takers. Also, there is a growing critique and challenge of traditional instruction and rote-memorization classroom activities by exploring alternative classroom activities (Category 1), such as project learning and problem-solving mathematics practices, including discovery and reasoning (Category 2). These tensions continue to evoke continued discussion among the mathematics teacher community on classroom activities and assessments.

II. CONTRIBUTION OF THE ARTICLE

Previous studies on mathematics education research communities have mainly focused on peer-reviewed journal articles rather than teacher practitioner journals (e.g., Inglis & Foster, 2018).

Moreover, some studies did not provide an interpretation of why certain lexicons were observed in a certain country or local context. However, Lee and Kim's study and its explicit explanation of the Korean contexts provide a deeper understanding of what lexicons Korean mathematics teachers frequently use. Furthermore, this study sheds light on the effect of social context on teachers' mathematics instruction, perception, values, and community such as the effect of COVID-19 and college entrance exams in Korea. However, it is important to note that the authors selected a specific group of mathematics teachers (i.e., members of the Korean Society of Teachers of Mathematics) as the sample for this study.

The first contribution of Lee and Kim's study was to explain why certain lexicons receive more attention than others based on social, cultural, and political contexts. Lee and Kim's (2022) other vital contributions to literature and practice stemmed from their methodological approach. They employed text-mining techniques and subsequent regression analysis to examine a voluminous corpus of data. A research community in mathematics education has increasingly employed natural language processing methods to trace and analyze the patterns of topics (e.g., Shin, 2020). In addition to this text mining, other forms of natural processing analysis have been conducted, including text clustering and sentiment analysis. Along with this research trend, Lee and Kim used Python software and its packages to efficiently detect pedagogical lexicons and their changes in frequency. This approach provided more accurate information compared to manual coding, which can be time-consuming and prone to subjective judgments by researchers.

Moreover, unlike previous studies, this study implemented a text-mining technique on manuscripts written in Korean, not English. Text mining on Korean language documents poses technical challenges, leading most previous studies to analyze only English abstracts (e.g., Shin, 2020). However, analyzing only English abstracts from Korean manuscripts may not accurately represent the language and lexicons used in the full text written in Korean. Lee and Kim's study overcame this limitation by examining the full Korean text presented in the journal, which was rarely attempted by Korean researchers.

Considering the recent reform efforts of Korean mathematics curricula to emphasize mathematical processes and competency (Ministry of Education, 2022), this

study has the potential to bridge the gap between the research community and practitioner community in their discussion about the aspects of mathematics educators need to be prioritized to achieve the overall and current goals of mathematics education.

III. LIMITATIONS AND IMPLICATIONS

Despite the value of the research findings, this study has three limitations. First, the study only examined lexicons presented in a single mathematics teacher education journal. Thus, this study could not ensure the community and social-cultural contexts of other mathematics teachers who did not publish papers in this particular journal. Therefore, readers should be cautious when interpreting the results of the study. Second, the categorization of each lexicon is a relatively subject process. For example, the authors classified "engagement" as an element of a category labeled "assessment." However, this lexicon could be an element of another category, "Teaching and learning activities." Similarly, "classroom presentation" could be classified into elements of "Teaching and learning activity," not "Lesson structure." Therefore, the study's findings may differ based on the researchers' interpretation of the collected data.

Third, using linear regression analysis was not an ideal method to examine the changes in the frequency of pedagogical lexicons. Linear regression analysis creates a single line based on the two variables (x- and y-axes), which may not accurately represent variances in the data. Because when researchers examine data collected over a long period, "the individual rate of change is not constant" (Grimm et al., 2016, p. 201), and data are likely to show nonlinearity. For example, the authors stated that the lexicon "Discovery" showed the most increment during the past 10 years by plotting the diagonal line (see Figure 1). However, a more precise examination of the data reveals that the data showed a cubic model (see the dashed line in Figure 1). Therefore, it would be safe to interpret that the lexicon "Discovery" showed a fluctuation pattern: the interest was diminished between 2014 and 2016 but increased after that.

Considering the limitations of Lee and Kim's (2022) study, future studies could explore several mathematics teacher education journals to verify the findings of this study. Furthermore, future studies might reclassify the categorization framework (Table 1) and use a non-linear model (e.g., quadratic or cubic) to more precisely examine the change in the pedagogical lexicon in the Korean mathematics teacher community. Additionally, cross-cultural studies could be conducted by comparing the text data used by mathematics teachers in Korea and other countries. For example, Xu and Mesiti (2022) examined the mathematical talk used by US and Japanese mathematics teachers to understand how they enhanced student mathematical investigations. Thus, implementing cross-cultural studies may provide more vivid insights into the characteristics of the Korean mathematics teacher community.
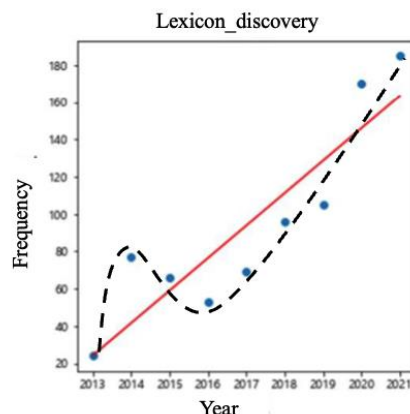
Figure 1. The frequency change of the lexicon "Discovery" over time
Note. The diagonal line was plotted by Lee and Kim (2022), whereas the dashed line was re-plotted by the study's reviewers.

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