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High School Students' Perceptions of Mathematics Teachers' Implementation of UDL-Based Practices and Technology in Mathematics Classes

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Abstract: *The purpose of this survey-based study was to investigate high school students' perceptions of mathematics teachers' implementation of Universal Design for Learning (UDL)-based practices and technology in their mathematics classes in 2017. A total of 303 high school students in South Korea participated in this online survey on teachers' use of technology for instructional practices, the frequency of technology tool use, and the meeting of UDL guidelines in mathematics instruction. According to frequency analysis, high school students generally perceived their teachers' mathematics teaching as somewhat positive in providing multiple means of representation, action and expression, and engagement. However, mathematics teachers' implementation of technology tools in their mathematics classes was generally limited. This study indicated significant and positive relationships between variables regarding the use of technology tools and teachers' efforts to follow the UDL guidelines. Applying the Chi-squared test, we further examined how each survey result differed according to high school students' academic achievements and grade levels.*

Keywords: High school; Mathematics; Technology; Universal Design for Learning

1. Introduction

The Universal Design for Learning (UDL) guidelines [1] emphasize optimizing all learners' access to tools so that they have the opportunity to use the tools and participate in the learning process. Rao et al. [2] validated the UDL Reporting Criteria, defining the essential elements of UDL applications and providing specific guidelines for each element. Previous studies have examined the efficacy of UDL framework-embedded instruction, finding large effects on students' learning of science, literacy, and social skills content, as well as on their engagement in classroom activities [3, 4]. Other researchers have designed digital learning environments based on the UDL framework to maximize the access and learning of all students [5, 6]. Despite these efforts to construct and validate the UDL framework in various learning environments, few studies have evaluated practices based on the UDL framework used by mathematics teachers in the classroom. Although previous studies have surveyed teachers about their actual mathematical practices [7] or UDL-based teaching practices [8], few studies have examined students' perspectives toward their teachers' implementation of mathematics practices in the classroom with respect to the UDL guidelines. Students are important stakeholders who engage in actual learning experiences and receive quality instructional support in the classroom. Thus, it is important to investigate students' perceptions on their teachers' instructional practices. To fill the current void of research on teachers' implementation of instructional practices in the classroom and the role of technology based on the UDL framework, we surveyed high school students in various classroom circumstances and asked how their teachers supported them in mathematics classrooms.

The purpose of this survey-based study was to investigate high school students' perceptions on mathematics teachers' implementation of UDL-based practices and technology in their mathematics classes. Based on the survey responses, we further examined whether high school teachers' instructional practices were associated with students' academic achievements or high school year levels. The following research questions were examined:

RQ1. To what extent do high school mathematics teachers implement UDL-based practices when teaching mathematics?

RQ2. How frequently do high school mathematics teachers use technology for various instructional practices?

RQ3. How frequently do high school mathematics teachers use various technology tools?

RQ4. What are the associations among high school mathematics teachers' use of technology tools, frequency of the use of technology for various instructional practices, and frequency of meeting UDL guidelines in their mathematics classes?

2. UDL-Based Instruction

UDL is an educational system based on the science of learning and cognitive neuroscience that guides the development of a flexible learning environment that can accommodate the differences in individual learners [9]. Within the mandate for active mathematics learning, educators face a daunting set of challenges. According to the national-level special education curriculum in 2015, the Korean Ministry of Education [10] stated that educators apply UDL principles in teaching and learning methods for students, considering students' strengths and needs and promoting their active participation in the learning. The recently released educational policies in South Korea (e.g., 2020 Special Education Operation Plan and Fifth Five-Year Development Plan for Persons with Disabilities) also highlight sharply increased accountability for raising the academic achievement of all students, including those with disabilities in inclusive school environments.

UDL requires careful planning by teachers, and examples of UDL classroom instruments include posted lesson goals, assignment options, flexible workspaces, regular feedback, and digital and audio text [1]. Just as universally designed buildings provide options that accommodate a broad spectrum of users, universally designed tools and curricula offer a range of options for accessing and engaging with learning materials. In this learning design, the following three guidelines should be applied to all learners with diverse educational needs: "multiple means of representation" (UDL1), "multiple means of action and expression" (UDL2), and "multiple means of engagement" (UDL3) [1].

UDL-based instruction overcomes unnecessary barriers to learning. The basic premise of UDL is that barriers to learning occur when the learner interacts with the curriculum—they are not solely the result of the capacity of the learner. UDL-based instruction has been found to work for a variety of students [9]. It is also a preventive strategy for students with risk factors such as low literacy, poor mathematics skills, and overall poor attendance and performance (as part of more specialized small-group interventions, e.g., adult mentors, tutors, prescription reading programs, self-management). UDL is also used to aid decision making about ongoing interventions and support for students receiving special education services with an Individualized Education Program [11].

3. Roles of Technology in UDL-Based Instruction

Technology can play an important role in the design and implementation of the UDL framework in K-12 classrooms. In general, accessibility refers to the elimination of barriers to make buildings, roads, and indoor and outdoor facilities equally accessible to all people, regardless of their age, ability, and background. Furthermore, accessibility to information, communication, and other services has become essential worldwide [12]. In the field of education, the accessibility issue was considered when designing the UDL framework to improve and optimize teaching and learning for all people [13]. Because it applies the pedagogical theory of maximizing students' access to a general curriculum regardless of their abilities or disabilities, UDL has become increasingly popular over the last two decades [2]. According to the guidelines established by CAST [1], teachers should design lessons that provide multiple means of engagement (e.g., optimizing students' interest, preference, and autonomy), multiple means of representation (e.g., offering various visual and auditory stimuli), and multiple means of action and expression (e.g., using various tools for communication) for all learners, including students struggling with mathematics. By using technology in mathematics instruction, teachers can plan and implement lessons, ensuring that their instructional support meets each student's needs.

Technology is discussed in the context of UDL-based instruction because it can reduce barriers and support learning beyond the capabilities of more static learning tools. The use of technology in UDL-based instruction enables the flexible provision of the core curriculum by instructors so that students can access it in a personalized manner. Technology also has the advantage of enabling an interactive network; for example, by using text-to-speech programs in digital media to read words aloud to students with dyslexia, appropriate support can be provided to these students or others with disabilities or learning difficulties [9]. Technology is an important factor in UDL implementation, but it is not a requirement, because UDL-based instruction can also be realized through low-technology and no-technology approaches.

4. Method

4.1 Participants and Setting

As shown in Table 1, 330 current high school students participated in this online survey. There were 174 female and 156 male students who were in either high school year one (n = 110), year two (n = 114), or year three (n = 106). Students varied in their academic performance in high school mathematics: low achievement (n = 53), average achievement (n = 191), or high achievement (n = 86). Regarding geographic location, the students were from several cities, including Seoul (n = 88) and Gyeonggi (n = 76). Prior to starting the study, we underwent a review by the Institutional Review Board (IRB) at the first author's university and received approval for the study. To recruit high school students willing to participate in this study, we contracted a research survey company and delivered an invitation letter to people who had previously agreed to receive an invitation letter for a survey from the company. People who agreed to participate in the survey initiated the survey. Respondents agreed to a consent statement before joining the online survey and were able to access the survey through any Internet-connected device, such as a computer, tablet, or smartphone.

Table 1. Demographics of respondents (N = 330)

Variable		***n* (%)**
Gender	Male	156 (47.27)
	Female	174 (52.73)
Age	15	12 (3.64)
	16	106 (32.12)
	17	118 (35.76)
	18	89 (26.97)
	19	5 (1.52)
Year	High school 1	110 (33.33)
	High school 2	114 (34.55)
	High school 3	106 (32.12)
School type	Public high school	237 (71.82)
	Private high school	6 (1.82)
	Specialized high school	81 (24.55)
	Special-purpose high school	6 (1.82)
Geographical location	Seoul	88 (26.67)
	Daegu	20 (6.06)
	Incheon	20 (6.06)
	Gyeonggi	76 (23.03)
	Chungcheong	16 (4.85)
	Jeolla	30 (9.09)
	Gyeongsang	27 (8.18)
	Other	53 (16.06)
Major	Humanity and social science	173 (52.42)
	Science and engineering	124 (37.58)
	Arts and physical education	23 (6.97)
	Other	10 (3.03)
Academic achievement level	Low	53 (16.06)
	Average	191 (57.88)
	High	86 (26.06)

4.2 Instruments

A quantitative survey questionnaire was developed to examine how high school mathematics teachers implement technology for various instructional practices, what technology tools are used, and whether the UDL guidelines are met. In the process of developing the questions, we reviewed previous survey-based studies [12]. To examine how high school students evaluated mathematics teachers' incorporation of UDL guidelines, we followed CAST's [1] UDL principles (i.e., provide multiple means of representation, action and expression, and engagement. Then, to verify the validity of the content by external expert groups in the field, we went through an iterative review and revision process as a team. For the external review, one faculty member in a special education department and one in a general education department checked the suitability of each question. We corrected each item based on the expert evaluation and checked whether high school students understood the intention and wording of each question. After this process, the final questionnaire contained items on background information (seven questions), the frequency of using technology for various instructional practices (eight questions), the frequency of using technology tools (seven questions), and the meeting of UDL guidelines in mathematics instruction (nine questions). For the frequency question, we used a 5-point Likert scale (5 = daily, 4 = one or two times per week, 3 = one or two times per month, 2 = one or two times per semester, 1 = one or two times per year). The internal consistency (Cronbach's alpha, α) of the survey items was .78 for the use of technology for various instructional practices and .77 for the use of technology tools. The internal consistency ranged from .87 to .91 for meeting UDL guidelines in high school mathematics classes.

4.3 Data Collection and Data Analysis

Following the IRB's process, we collected online survey data during the spring semester in 2017. We used a digital online survey platform for data collection and monitored the number of completed responses. When respondents agreed to participate in the survey, they clicked a button in the survey window that corresponded to the statement, "I agree to participate in the study." All participants could access the online survey using any device in any location. All responses were automatically saved on the system as .sav and .csv files. For the data analysis, we took the following approach. Data were saved as a .csv file for use with R and Stata programs. Before running the main analysis, we calculated Cronbach's α for each survey item as a measure of the internal consistency or reliability. We then conducted a frequency analysis for each survey category to respond to RQ1–3. To determine the statistical differences in categorical survey items by students' academic achievement and high school year levels, we applied Pearson's chi-squared tests as a secondary analysis. For the final research question, Spearman's correlation analysis was conducted and the associations between the variables were explored.

5. Results

5.1 High School Mathematics Teachers' Implementation of UDL-Based Practices (RQ1)

As shown in Table 2, more than half of the high school students returned "neutral" and "agree" responses to mathematics teachers' incorporation of UDL guidelines in all aspects. Regarding mathematics teachers' efforts to provide multiple means of representation (UDL1), the teachers were perceived as providing a variety of learning materials to help in students' comprehension (31.21% agree and 38.48% neutral), followed by providing a variety of resources to help students understand new information (28.48% agree and 41.52% neutral) and providing students with multiple options to understand texts and symbols with ease (27.58% agree and 43.03% neutral).

High school students also more frequently demonstrated neutrality or agreement with mathematics teachers' provision of multiple means of action and expression (UDL2). Teachers were deemed to be encouraging students' fluency in learning by helping them express themselves well (27.58% agree and 42.12% neutral), followed by providing a variety of tools to help students deal with learning materials (21.21% agree and 42.42% neutral) and using a variety of methods to help students create activities that require high-level thinking (18.18% agree and 42.42% neutral).

With respect to providing multiple means of engagement (UDL3), more than half of the respondents indicated that their mathematics teachers helped students organize their own assignments, review their own learning situations, and establish rules (27.58% agree and 41.21% neutral). This response was followed by teachers' efforts to provide multiple means of emotional support for students to pursue their efforts in class

(24.24% agree and 41.52% neutral) and to use varied strategies to increase student engagement and interest in class activities (22.42% agree and 38.48% neutral).

As shown in Table S1 of the online supplemental materials [14], chi-squared tests of significance did not indicate a significant difference regarding mathematics teachers' implementation of UDL-based practices, measured by their students' academic achievements (χ^2 ranged from 6.94–14.23, *p*s > .05) and high school year levels (χ^2 ranged from 7.17–14.68, *p*s > .05).

Table 2. Implementation of UDL-based practices in high school mathematics classes (%)

UDL checkpoint	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
1. Provide multiple means of representation					
1.1. Provide a variety of learning materials to help in students' comprehension	6.36	12.12	38.48	31.21	11.82
1.2. Provide students with multiple options to understand texts and symbols with ease	6.67	12.12	43.03	27.58	10.61
1.3. Provide a variety of resources to help students understand new information	6.97	12.73	41.52	28.48	10.30
2. Provide multiple means of action and expression					
2.1. Provide a variety of tools to help students deal with learning materials	10.61	16.06	42.42	21.21	9.70
2.2. Encourage fluency in learning by helping students express themselves well	7.88	13.03	42.12	27.58	9.39
2.3. Use a variety of methods to help students create activities that require high-level thinking	10.61	20.30	42.42	18.18	8.48
3. Provide multiple means of engagement					
3.1. Use varied strategies to increase student engagement and interest in class activities	8.48	17.58	38.48	22.42	13.03
3.2. Provide multiple means of emotional support for students to pursue their efforts in class	9.39	12.73	41.52	24.24	12.12
3.3. Help students organize their own assignments, review their own learning situations, and establish rules	8.18	12.73	41.21	27.58	10.30

5.2 High School Mathematics Teachers' Use of Technology for Instructional Practices (RQ2)

As shown in Table 3, high school students perceived that their mathematics teachers applied technology to various instructional practices. Approximately 60.61% of the 330 respondents said that their teachers used technology daily in teacher-directed explanatory instruction. Mathematics teachers used technology more frequently, once or twice per week, for individualized supplementary lessons (14.24%), individualized advanced lessons (12.73%), tests and quizzes (11.21%), and progress monitoring (9.70%). Teachers implemented technology infrequently in other instructional practices: small-group activities, paired practices, and coaching. Teachers implemented technology least frequently in coaching students during break times (71.21%, once or twice per year).

As shown in Table S2 [14], chi-squared tests of significance again indicated no significant association between the frequency of applying technology to various instructional practices and high school students' academic achievement levels in most cases (χ^2 ranged from 5.71–14.07, *p*s > .05). However, regarding teachers' paired practice, students with average academic achievements noticed more frequent use of technology in their mathematics classes than did students with low or high academic achievements ($\chi^2 = 16.63$, $p < .05$). The high school students' year levels did not appear to have an impact on mathematics teachers' use of technology for all instructional practices (χ^2 ranged from 5.65–12.14, *p*s > .05).

Table 3. Use of technology for instructional practices (%)

Practice	1–2 times per year	1–2 times per semester	1–2 times per month	1–2 times per week	Daily
Teacher-directed explanatory instruction	11.52	5.45	7.58	14.85	60.61
Small-group activity	55.45	15.45	13.64	7.88	7.58
Paired practice	60.30	11.21	16.36	6.97	5.15
Individualized supplementary lesson	59.70	11.52	9.70	14.24	4.85
Individualized advanced lesson	63.03	10.91	9.39	12.73	3.94
Progress monitoring	30.30	26.67	31.21	9.70	2.12
Test and quiz	30.61	30.91	23.03	11.21	4.24
Coaching	71.21	15.45	9.70	2.42	1.21

5.3 High School Mathematics Teachers' Use of Technology Tools (RQ3)

As shown in Table 4, high school students perceived the use of all types of technology tools as infrequent. Out of the 330 respondents, more than half indicated that all the technology tools were implemented in their mathematics classes only once or twice per year. Despite this lower use of technology tools in general, high school mathematics teachers used computers relatively frequently; 14.24% of respondents perceived that their mathematics teachers used computers daily, followed by the smartboard (7.88%) and digital textbooks (6.67%).

In contrast, high school mathematics teachers used tablets (81.21%), smartphones (81.21%), and timers (81.21%) once or twice per year. As shown in Table S3 [14], chi-squared tests applied to assess the significance of the association between the frequency of applying technology tools and high school students' academic achievement levels indicated no significant relation between the categorical variables (χ^2 ranged from 2.45–11.51, *p*s > .05). Furthermore, across years one to three, mathematics teachers showed similar frequency patterns in applying technology tools in most cases (χ^2 ranged from 4.04–13.12, *p*s > .05). However, mathematics teachers in years one and two used tablets significantly more frequently than those in year 3 (χ^2 = 18.44, p < .05).

Table 4. Use of technology tools (%)

Practice	1–2 times per year	1–2 times per semester	1–2 times per month	1–2 times per week	Daily
Digital textbook	73.33	7.27	6.97	5.76	6.67
Computer	53.94	10.91	10.00	10.91	14.24
Tablet	81.21	6.06	5.76	3.33	3.64
Smartphone	81.21	8.48	5.76	3.64	0.91
Calculator	79.70	10.00	5.45	4.55	0.30
Timer	81.21	8.48	7.88	2.42	0.00
Smartboard	76.67	6.36	4.55	4.55	7.88

5.4 Associations among Related Variables (RQ4)

Figure 1 summarizes the bivariate correlations among the variables. In many cases, the relationships between the included variables were positive and significant. Table S4 [14] depicts the Spearman correlation results between the variables. In particular, the frequent use of technology tools and the implementation of UDL guidelines were significantly correlated with the use of technology for instructional practices (*r* ranged from .11–.74, *p*s < .05), except for the use of technology in teacher-directed explanatory instruction (Practice 1) and the provision of a variety of learning materials to help in students' comprehension (UDL 1.1). In terms of the associations between high school mathematics teachers' use of digital textbooks (Tool 1) or tablets (Tool 3) and teachers' mathematics instruction, meeting the UDL guidelines showed some degree of inconsistency. Regarding the relationships between teacher-directed explanatory instruction (Practice 1) and other variables, the results showed no significant association with other variables and even maintained a somewhat negative relationship.

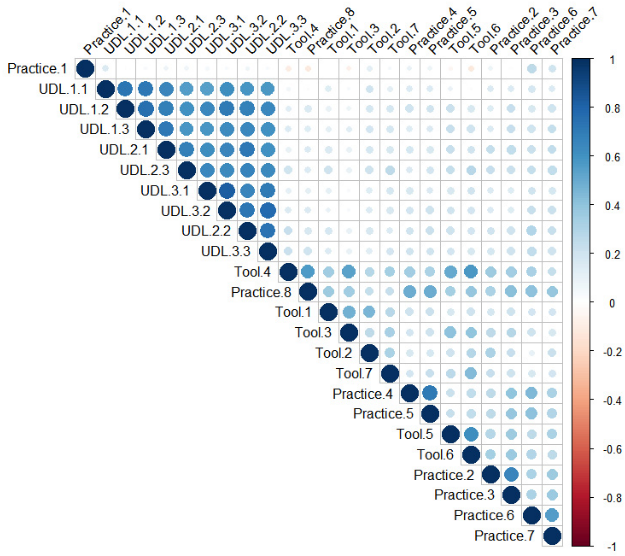

Figure 1. Bivariate correlations among variables. Association between the implementation of each variable pair. The size of each circle is proportional to the amount of cell contribution. Blue cells specify a positive association, and red cells indicate a negative association.

6. Discussion

In this study, we aimed to investigate high school students' perceptions on mathematics teachers' implementation of UDL-based practices and technology in their mathematics classes. We examined how high school students perceived their teachers' implementation of mathematics teaching following UDL guidelines, the use of technology for various instructional practices, and the incorporation of technology tools in mathematics classes. We also evaluated the effects of academic achievement and high school year level on these variables using chi-squared tests of significance. We further examined the associations among all the variables included in this survey-based study. We address the key findings in the following sections.

6.1 High School Mathematics Teachers' Implementation of UDL-Based Practices (RQ1)

In this study, high school students perceived their teachers' mathematics teaching as somewhat positive in providing multiple means of representation, action and expression, and engagement [1]. Abell et al. [15] emphasized that high school students demonstrate more interest and engagement in curricula that are relevant and adaptable to their learning styles, strengths, and interests. Here, we found no statistically significant association between academic achievement or high school year level and teachers' implementation of UDL-based practices. Regardless of different levels of academic achievement and different high school years, the respondents all shared a similarly positive perception of their teachers' mathematics instruction following UDL guidelines.

The educational policy in the revised national curriculum for all students in South Korea [16] states that students are expected to acquire essential learning skills in various educational environments that are accessible to all learners with various degrees of academic challenges and characteristics. UDL is an approach that provides opportunities for mathematics learning for all. Smith et al. [17] observed that flexibility, choice, and engagement within the UDL framework can ensure meaningful cognitive access for all students, including those who struggle with mathematics.

6.2 High School Mathematics Teachers' Use of Technology for Instructional Practices (RQ2)

The high school students' responses showed that mathematics teachers applied technology to various instructional practices, with a somewhat skewed response to the statement about teacher-directed explanatory instruction. This finding is partially aligned with Shin et al.'s [12] findings on the frequent use of teacher-led modeling, the review of previous topics, and the provision of feedback among both general and special education mathematics teachers in South Korea.

Contrary to the frequent use of technology in teacher-directed explanatory instruction, mathematics teachers implemented technology relatively infrequently in all other instructional practices, including small-group activities, paired practices, individualized supplementary or advanced lessons, progress monitoring, tests and quizzes, and coaching. This limited use of technology in mathematics instruction was a somewhat unexpected result, considering the positive attitudes toward incorporating technology and the high degree of technology self-efficacy among secondary mathematics teachers in South Korea [18]. Lee and Whang [19] described the unexpected pattern that many mathematics teachers in South Korea have a positive attitude about utilizing technology, yet a low rate of utilization of technology in their mathematics classes. Although the use of technology itself does not guarantee the success of students' understanding of mathematics, incorporating technology into mathematics classes can assist teachers in providing options and accommodations for students struggling with mathematics; it helps them participate in mathematics classes and benefit from intensive instruction [20, 21].

6.3 High School Mathematics Teachers' Use of Technology Tools (RQ3)

Given the limited use of technology for instructional practices, the survey results corroborated the limited use of technology tools in general [22]. When asked about high school teachers' status regarding the use of technology tools, surprisingly, high school students perceived that many teachers used technology tools (e.g., tablets, smartphones, and timers) only once or twice per year. There was a slight variation in the use of tablets in classes at different levels of high school. First- and second-year high school students observed that their mathematics teachers incorporated tablets significantly more frequently than did third-year high school students. Despite the restricted use of technology tools in general, a relatively high number of high school mathematics teachers used computers, followed by digital textbooks and smartboards. This finding is somewhat consistent with Shin et al.'s [12] finding, demonstrating the limited use of smart devices, such as tablets and smartphones, in mathematics classes.

In developing K-12 education for the fourth industrial revolution and the future society, many researchers and policy makers have emphasized teachers' capacity to use various technologies (e.g., adaptive learning, virtual reality, and artificial reality) over the last decade [23, 24]. Unfortunately, with the COVID-19 pandemic, the future society has arrived quite suddenly. Cho et al. [25] found that mathematics teachers who had more information and communications technology (ICT) skills and a positive attitude toward ICT showed a higher intention to use ICT in their classes. Thus, mathematics teachers should understand how to use various technology tools and when to use different technologies to meet the needs of students struggling with mathematics.

6.4 Associations among Related Variables (RQ4)

The results of this study indicated significant and positive relationships between variables regarding the use of technology tools and teachers' efforts to follow the UDL guidelines. In particular, the use of technology for most instructional practices was significantly associated with each variable and showed a positive relationship. The implementation of small-group activities, paired practices, individualized supplementary lessons, individualized advanced lessons, progress monitoring, and tests and quizzes in mathematics classes were significantly associated with the frequency of using all the guidelines of UDL-based practices and all types of technology tools. These findings indicate that UDL is implemented better in small-group, student-centered learning environments that can provide customized classes to students with various academic achievement levels and remove barriers to learning mathematics [26, 27]. Therefore, in future teacher education programs, both pre-service and in-service teachers should be trained to plan and execute the UDL guidelines in their curricula and to connect various instructional practices and technology tools to better meet the needs of diverse students and increase the efficacy of the use of the UDL framework in mathematics classes.

6.5 Limitations and Recommendations for Future Research

This study has two main limitations and related recommendations for future research. The survey results showed somewhat dichotomous patterns in the implementation of technology in various instructional practices and the application of technology tools in high school mathematics classes. Many high school students perceived that their teachers implemented technology in teacher-direct explanatory instruction and most frequently used the computer as the primary technology tool in mathematics classes. However, in teaching mathematics to students with diverse academic and cognitive profiles, teachers should know about and meaningfully utilize technology to meet the UDL guidelines in their lessons. Educational technology ranges from low-tech to high-tech. The use of technology in UDL is not limited to high-tech options; as CAST [28] mentioned, "technology is not synonymous with UDL, but it does play a valuable role in its implementation and conceptualization" (p.10). It can be seen that UDL aims to transform how various technologies are utilized to create successful mathematics classes for all learners. Therefore, professional development teacher education programs should also be implemented from the perspective of UDL-based mathematics lesson planning and execution according to the rapidly changing characteristics and needs of classrooms [29]. The direction of teacher education should gradually move from UDL mathematics classes using computers or mobile devices (currently the most commonly used technologies) to classes using various technologies.

The relatively limited use of technology, in terms of both types of tools and instructional practices, could be related to the current transition in the educational system in schools. Over the last several decades, education in South Korea has been characterized by centralization and efficiency, as well as by rapid growth in the quantity and quality of both private and public education systems [30]. To reform the long-standing performance-oriented approach, the Korean Ministry of Education revised the national curriculum and the detailed curriculum expectations for individualization, student-centered learning, and creative and interdisciplinary core capability [10, 16]. Several studies have also shown that mathematics teachers have positive attitudes and intentions toward the use of technology in schools, but they do not know how and when to incorporate various technology-based instruction and tools [18, 19]. Particularly during this COVID-19 pandemic period, which required school closures, teachers' digital competence has been instrumental in adapting to new teaching and learning formats, such as remote and online teaching [31].

7. Conclusion

The three UDL guidelines are designed to ensure that the principles are applied to all learners with varying educational needs. CAST [1] emphasizes providing a variety of means to present information, different ways of expression, and varied means of participation; it also underlines considering learners' characteristics and needs when planning teaching and learning content. With the implementation of UDL-based practices, both general education and special education teachers can maximize student access to engaged learning in the inclusive classroom. Adapting textbooks can be considered one option for providing a means of presenting comprehensible materials to students both with and without disabilities [32, 33].

This study shows that the often-used instructional practice of teacher-directed explanatory instruction needs to be shifted to the direction of using technology as a means for student-centered classes (or self-directed classes) pursued in the UDL-based philosophy of practices. Technology should no longer be recognized as a learning aid or a motivational means, but as an essential tool for creating an interactive educational environment. This will require a change of thinking. Additionally, efforts must be made to improve the quality of technology to teach classes based on UDL practices (e.g., a variety of methods to help students create activities that require high-level thinking) as a means of creating an educational environment that promotes higher thinking ability, such as problem-solving learning, which is a representative teaching method of mathematics.

With the outbreak of the COVID-19 pandemic, the use of technology in education has become commonplace. This study has indicated that many in-service teachers might not be fully prepared to support and meet the needs of diverse students. In teaching mathematics to secondary school students who require intensive and individualized instruction, the use of appropriate technology can be an option to support them. To close the gap between the newly introduced demanding roles of high school mathematics teachers and the limited implementation of technology addressed in the current study, high school mathematics teachers should undergo quality training and validate their teaching by incorporating different forms of technology tools into various instructional practices. Such measures would be in line with meeting the needs of all students, including those struggling with mathematics, supported by the UDL principles [1] that provide multiple means of representation, action and expression, and engagement.

Conflicts of Interest: The authors declare no conflict of interest.

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