Key factors for Successful Integration of Technology into the Classroom: Textbooks and Teachers

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Abstract *The purpose of this paper is to investigate some causes of why technology has not been integrated into mathematics teaching by teachers We considered two aspects to examine these causes in this paper; Korean mathematics textbooks as teaching materials implementing technology, and teachers' concern on using technology and their levels of its use. First, we analyzed the role of technology in mathematics teaching and learning, especially concentrated on Korean secondary mathematics textbooks. Secondly, we surveyed Korean secondary mathematics teachers' concerns about integrating technology into their mathematics education and the teachers' level of its use in the mathematics classroom. We found that mathematics teachers need more proper information and support to integrate technology into teaching mathematics. Additionally, this paper suggests that educational researchers or administrators help teachers move toward more practical use of technology without emotional or physical barriers in mathematics classroom*.

1. Introduction

Over the last few decades the rapid development of technology has greatly influenced a wide range of fields throughout society. It also brought forth many changes to mathematics education. Mathematics educators have studied how to use technology effectively for learning and teaching mathematics and have tried to integrate technology into mathematics classroom. These studies showed that technology can lead improvement of mathematics learning and teaching in many aspects. Technology can foster a student to conjecture, justify and generalize mathematical contents by doing fast and accurate computation and analysis of various representations (See [1], [2]). Considering the educational advantages, many curricular documents in the whole world now emphasize integrating technology with mathematics education. Especially, [3] mentioned that technology is an essential tool for learning mathematics in the 21st century. In the case of Korean curriculum, technology was first mentioned in the Sixth Curriculum (1992). Furthermore, in the 2007 Revised Curriculum, the application scope of technology use was extended to be included in assessment contents, as well as teaching and learning mathematics (See [4], [5], [6]). The curriculums have greatly influenced Korean mathematics textbooks, which have included various examples using technology. Additionally, Korean mathematics teachers are highly dependent on their textbooks to teach mathematics. Students learn mathematics using the textbooks as well. In other words, it is Korean mathematics textbooks that have implemented Korean mathematics curriculum in the classrooms, exerting a strong influence on the mathematics education sites.

In [7] and [8], the integration of technology into mathematic education, especially at secondary levels, had not achieved all that many researchers and educators have expected. There are many constraints or barriers including educational environments. However, the crucial factor in integrating technology into mathematics education is the role of mathematics teachers (See [9], [10], [11]). A teacher has the right not only to choose methods to teach mathematics but also to implement the teaching methods in the classroom. Therefore, technology will never be integrated into mathematics education in practice unless the teacher makes use of technology in his or her classroom.

In this paper, we tried to investigate why technology has not been integrated into mathematics teaching by teachers We considered two aspects to examine the causes; Korean mathematics textbooks as teaching materials implementing technology and teachers' concern about sing technology and their levels of its use. First, we analyzed the role of technology in mathematics teaching and learning, especially concentrated on Korean secondary mathematics textbooks. Secondly, we surveyed Korean secondary mathematics teachers' concerns about integrating technology into their mathematics education and the teachers' level of its use in the mathematics classroom. We attempted to draw pedagogical implications in integrating technology into mathematics teaching and learning in an effective way through findings of this study.

2. The Role of Technology in Korean Secondary Mathematics Textbooks

(1) The Role of Technology in Mathematics Education

In this paper, we focused on two types of studies on technology in mathematics education in order to develop a new framework through our analysis on Korean mathematics textbooks; [12] and [13]. Firstly, Chua and Wu (2005)'s framework involved exploring, conjecturing, verifying, and generalizing as four key components of the role of technology in teaching and learning mathematics. These four components which make up the framework of Chua and Wu (2005) are provided as a visual representation in Figure 2.1. Secondly, Zbiek et al. (2007, p.1170) noted that advancing the collective wisdom about the role of technology in mathematics education requires careful distinctions between two different kinds of mathematical activity: technical and conceptual. Technical activity is concerned with tasks of mechanical or procedural performance, whereas conceptual activity is concerned with tasks of inquiry, articulation, and justification.

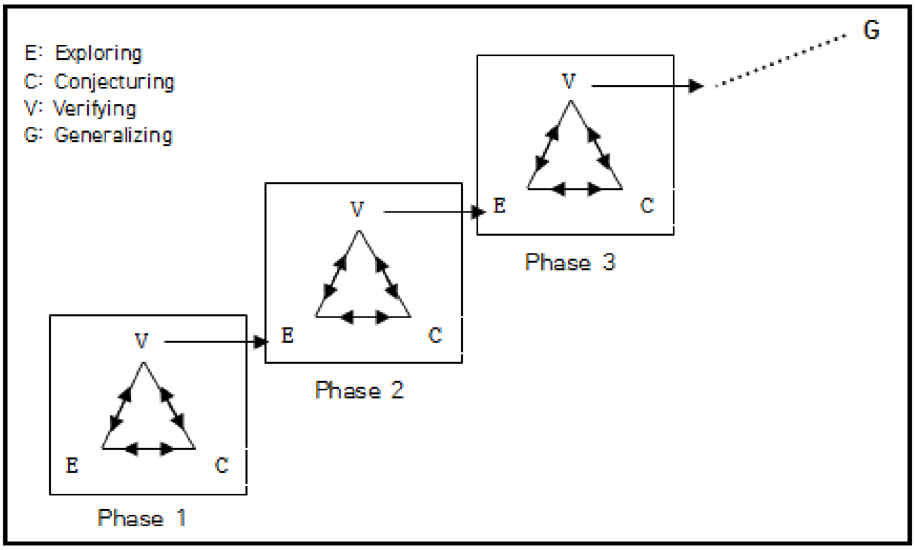


Figure 2.1. A visual representation of the four components

We modified results of their studies in order to construct our own framework which analyzes the role of technology in this study. Observing all examples of using technology presented in Korean mathematics textbooks, we found it necessary to divide the roles of technology into two categories according to the types of activity: technical and conceptual. Then we subdivided the categories. We considered whether examples presented in the textbooks are drill-and-practice (DP) or just for demonstration (DE). And, we identified how the components of E-C-V triangle are connected to each other. Finally, we constructed the framework which analyzes the role of technology such as Table 2.1.

Table 2.1. Framework of the role of technology

Role		Description of analysis
Technical	DP	· Students perform a given task by modeling example presented earlier or just compute numbers and mathematical expressions by using technology. · (e.g.) Solve the equation using given computer program.
	DE	· Textbook presents examples of using technology. However, a teacher may use the examples just for demonstration and students are not allowed any opportunities of being involved in activity.
Conceptual	E	· Students merely perform a given task by using technology according to instructions, and they are not allowed opportunities to come up with mathematical ideas or to identify a mathematical concept for themselves. · (e.g.) Find the equation of tangent line to the circle $x^2+y^2=25$ at the point $(3,4)$ by using computer program.
	E-C	· After students perform a given task by using technology according to instructions, they conjecture a mathematical concept based on their intuition or exploration. However, they are not allowed opportunities to verify their conjecture. · (e.g.) Draw two straight lines $y=-2x+3$ and $2x+y+5=0$, and think about the relation of position between them.
	E-V	· After students perform a given task by using technology according to instructions, they directly verify a mathematical concept visually through exploration without process of conjecturing the concept. · (e.g.) Draw a parallelogram and its diagonals, and then mark the length of the diagonals. By dragging a vertex of the parallelogram, you can examine and verify the property that two diagonals of a parallelogram bisect the other despite of changing position and size of the parallelogram.
	E-C-V	· After students perform a given task by using technology according to instructions, they conjecture a mathematical concept based on their intuition or exploration, and verify the conjecture. · (e.g.) Draw similar figures by using computer program and explore their properties. You can identify property and shape of the similar figures by changing ratio of similarity. Especially, you can conjecture relationship between ratio of similarity and ratio of the perimeter or ratio of the area because they are automatically calculated. Let's examine the properties of similar figures.

	E-V-C	· After students perform a given task by using technology according to instructions, they directly verify a mathematical concept visually through exploration, and conjecture the relations. · (e.g.) Draw various graphs of functions, and then shrink or enlarge around a specific point through compute program. By the observation, you can verify some properties on each point on the graph. Let's discuss about your findings and conjecture the meaning of a differential coefficient.
	E-V-G	· After E-V activity, students extend the given task to a new problem situation or articulate more general cases from the given task. · (e.g.) Construct a triangle, compute the sum of all the internal angles of the triangle, and then verify the sum is 180 degrees by changing shape of the triangle. By using computer program, draw various polygons, and compute the sum of all the internal angles of the polygons.
	E-C-V-G	· After E-C-V activity, students extend the given task to a new problem situation or articulate more general cases from the given task. · (e.g.) Draw a pentagon, measure the size of all the external angles of the pentagon, and then find the sum of the angles. By moving the vertex of the pentagon, observe the sum of all external angles of a pentagon. By using computer program, find the sum of the external angles of various polygons.

(2) Analysis of Korean Mathematics Textbooks

In this study, we examined all kinds of Korean mathematics textbooks in order to analyze the role of technology in teaching and learning mathematics according to the framework (Table 2.1).

Korean Junior Secondary Mathematics Textbooks

According to the analysis, technology in Korean junior secondary textbooks was mainly used as conceptual role than a technical one. The conceptual role of technology made up almost 65 percent of the total, but 'E' and 'E-V' accounted for about 50 percent of the total activities. According to the data of the senior secondary textbooks, the activities in Korean junior secondary mathematics lack examples including technology as a conceptual role, such as conjecturing, verifying and generalizing.

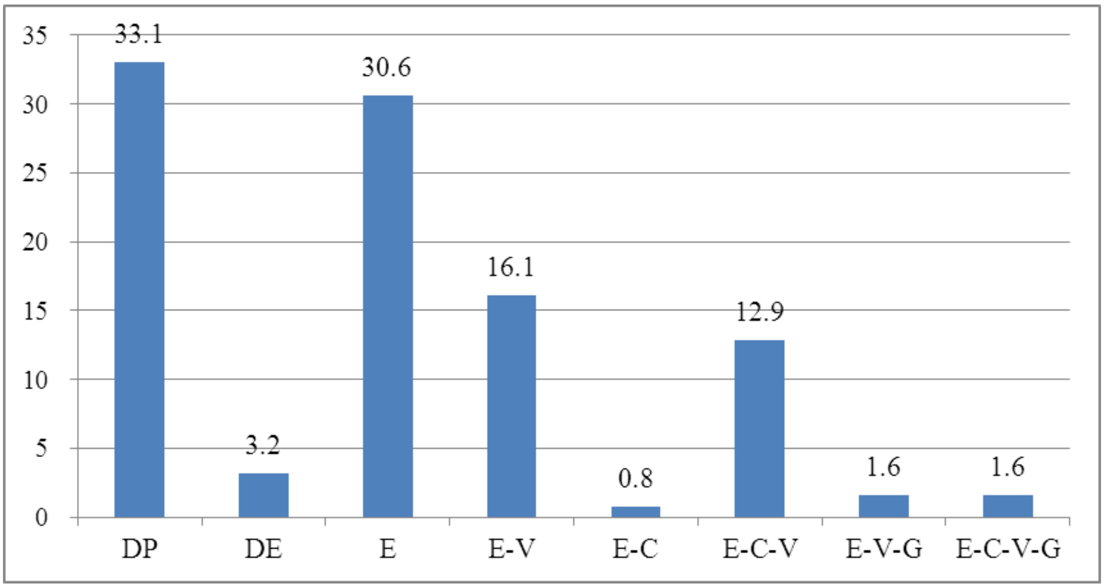


Figure 2.2. The role of technology in Korea junior secondary mathematics textbooks

As we analyzed below Geometry took up the largest number of activities in the junior secondary mathematics textbooks. Geometry activities mostly made use of technology as a conceptual role more often than a technical one. As the examples above indicate, the key advantage of using technology in mathematics education is visualization of mathematical concepts not in a mind but in a computer screen. This is the reason why almost half of the activities were dealing with geometry.

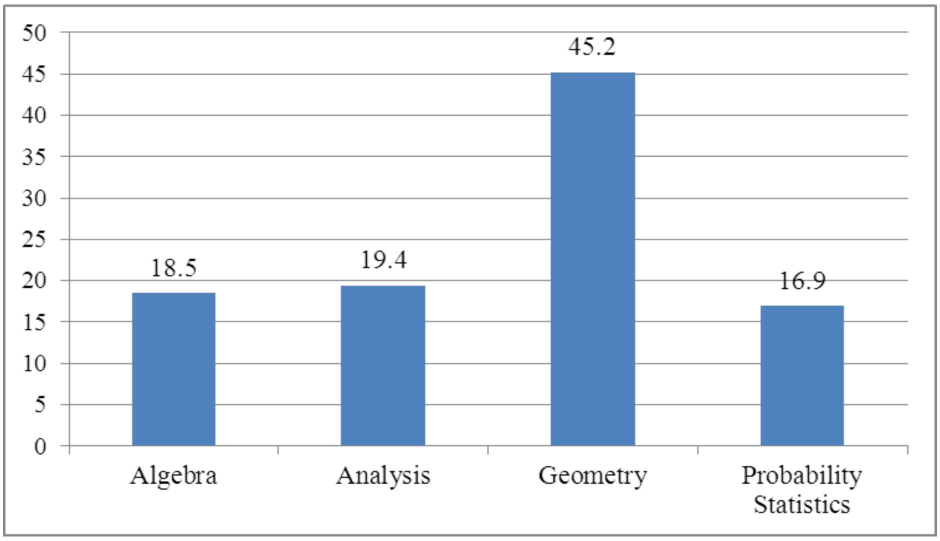


Figure 2.3. Distribution of activities with technology according to strands

The two figures, Figure 2.4 and Figure 2.5 below show the different roles of technology in the same mathematical strand, such as 'DP' and 'E' respectively. In Figure 2.4, students are simply required to enter the expression into the input window according to directions. In other words, students are required to make use of technology passively through instructions – guidance by a teacher or given materials – during the process of their problem solving. Students are instructed to merely draw graphs of various functions using these kinds of technology, which can be considered quite easy and simple. What this passive role of students in these activities mean is it is possible that the activities did not give students enough opportunities to come up with ideas to solve the problem on their own or display their problem solving. Therefore the example below as categorized as the 'DP' role of technology.

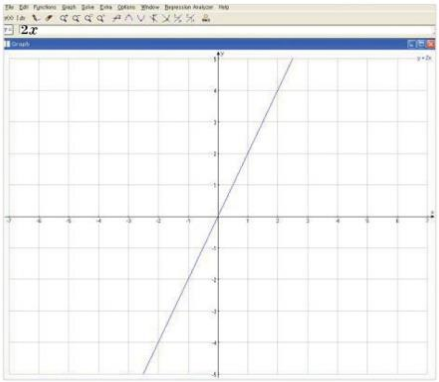
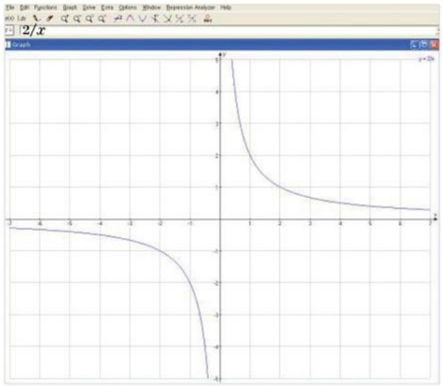
① Enter '$2x$' into the input window.	② Enter '$\frac{2}{x}$' into the input window.
	

Figure 2.4. An example of 'DP' role of technology in Functions

Figure 2.5 shows an example of 'E' in the unit of functions. This activity is aimed at identifying features of the functions such as $y = ax\ (a \neq 0)$ and $y = \frac{a}{x}\ (a \neq 0, x \neq 0)$. Through drawing various graphs of functions which display these forms on a screen, students can understand the important features of the functions easily. Specifically, students can figure out some features of the functions through the activities and may find that the graphs are all laid on the first and third quadrants of the coordinates when $a > 0$, and conversely on the second and fourth quadrants when $a < 0$. In addition, students will be able to grasp/understand that all graphs of $y = ax\ (a \neq 0)$ pass through zero, and the more the absolute value of a are high, the more the graph gets near to y-axis. Also, in the graphs of $y = \frac{a}{x}\ (a \neq 0, x \neq 0)$, the higher the absolute value of a is, the farther the graph is from zero. Thus the example was classified 'E' because the use of technology helps students to visualize the mathematical concepts and leads them to understand what they are learning.

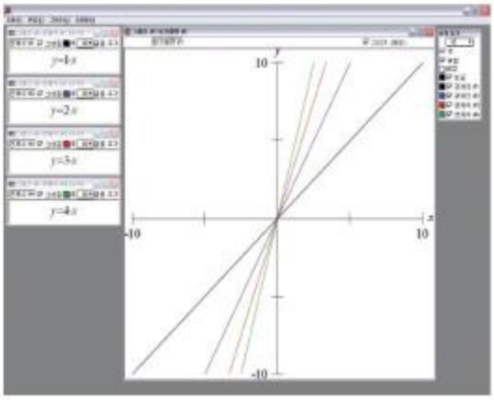
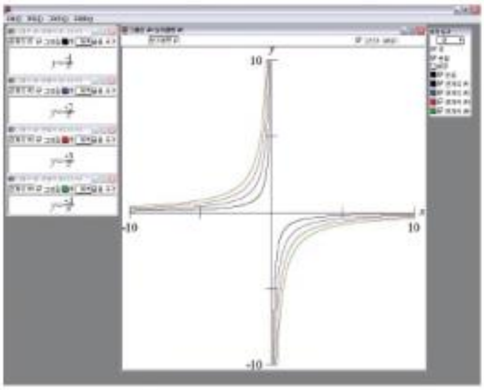
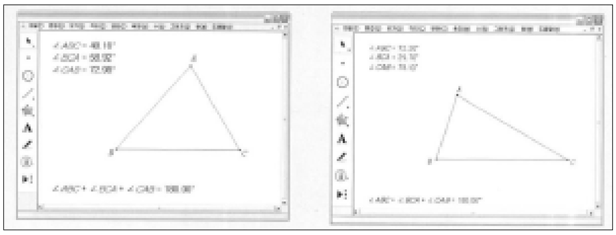
	
The graphs of $y = ax$, $a > 0$	The graphs of $y = \frac{a}{x}$, $a < 0$

Figure 2.5. An example of ‘E’ role of technology in Functions

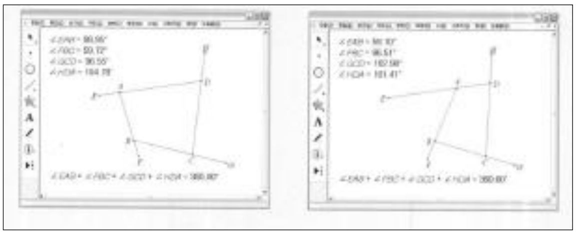
The examples including ‘Generalizing’ are made up of two sorts of role of technology, such as ‘E-V-G’ and ‘E-C-V-G’. The most distinctive feature of the examples is whether or not students have an opportunity to conjecture through their explorations using technology. In the case of ‘E-V-G’ Figure 2.6, students construct a triangle, compute the sum of all the internal angles of the triangle, and then verify whether the sum is 180 degrees by changing shape of the triangle. After that, they construct a quadrilateral, and do it the same way as they did in the activity of triangle. Students follow the directions given by a teacher or materials during the activity. In other words, the teacher or given materials instruct students specifically in the property they have to ind or verify in the given figures. Following ‘E-V’, students draw various polygons and compute the sum of all the internal and external angles of the polygons by using computer program.

① Find the sum of all the internal angles of



triangle

② Find the sum of all the external angles of



quadrilateral

③ Find the sum of all internal and external angles of the polygons by using computer program

Figure 2.6. An example of ‘E-V-G’ role of technology

Korean Senior Secondary Mathematics Textbooks

According to the study, the number of the activities such as ‘DP’ and ‘DE’ made up almost 60% of the examples at the senior secondary level. It means that technology mainly plays a technical role in activities of Korean senior secondary mathematics textbooks. Moreover, the number of technical examples is larger than that at the junior level. The data showed that the activities in Korean senior secondary mathematics textbooks lack examples with technology as a conceptual role, such as exploring, conjecturing, verifying and generalizing.

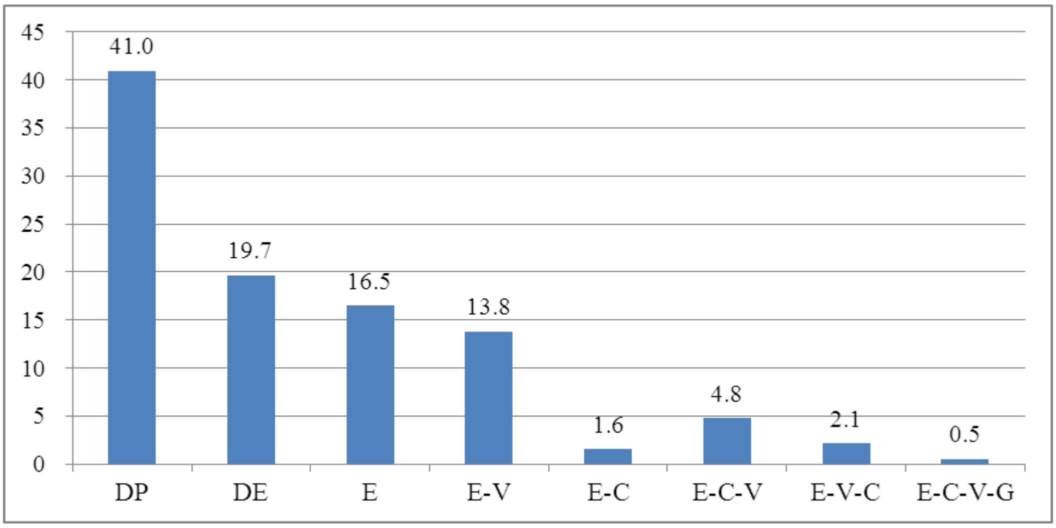


Figure 2.7**.** The role of technology in Korea senior secondary mathematics textbooks

In the case of Korean senior secondary mathematics textbooks, there is an obvious difference between the activities in senior textbooks and those in junior textbooks. While the examples of junior secondary mathematics textbooks are mainly based on geometric contents, about half of the activities at the high level include Analysis among the mathematical domains. The mathematical strand of the activities evenly consists of functions, limit and calculus while technology in the activities is evenly composed of 'DP' or 'DE'.

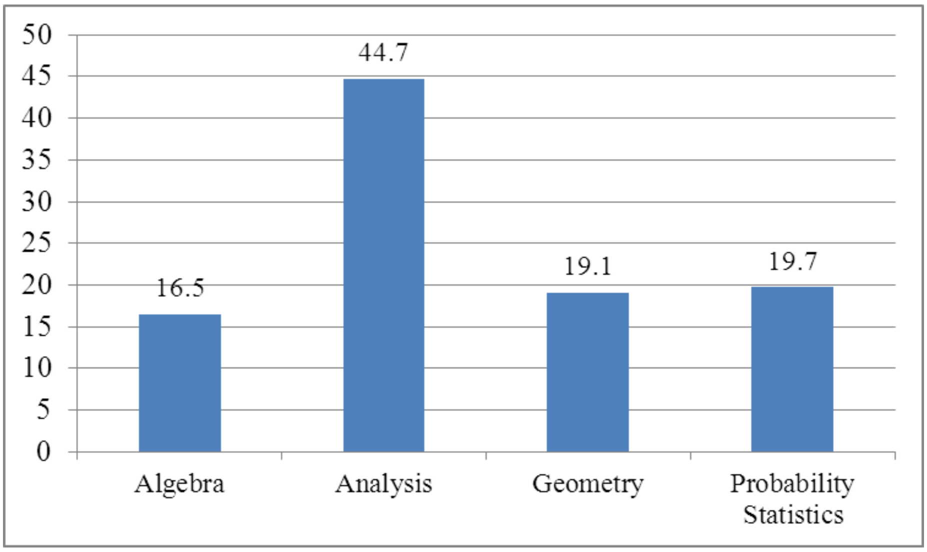


Figure 2.12. Distribution of activities with technology according to strands

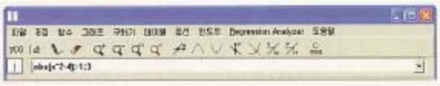
The examples of activities containing the technical role of technology in the senior textbooks consisted of solving equations according to teacher's directions or instructions of programs. It also consisted of finding values of data, and others such as standard deviation and variance, and computing definite integrals.

Find the area of $y = x^2 - 4$ (surrended by $x - axis, x = -1, x = 3$)	Let's find approximate of $\int_{-1}^{3} \lvert x^2 - 2x \rvert dx$ using the computer program.

with the program.

Step1: Run the program, click $\int dx$

Step2: Input abs(x^2−4);−1;3 into the window.



Step3: Press the enter key, and then you can find the answer.

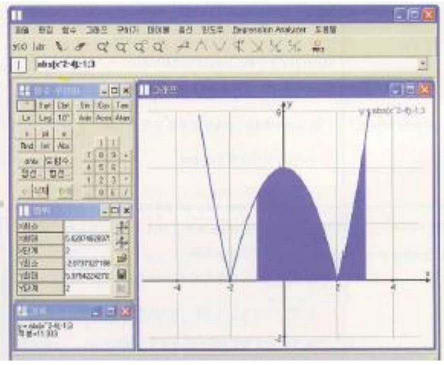
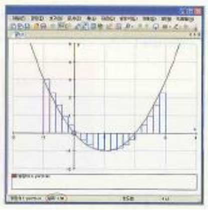
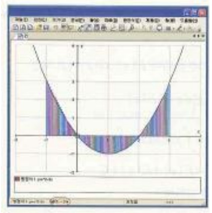


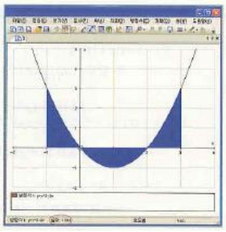
Figure 2.8. An example of 'DP'



The number of rectangles = 20 → 1.36



The number of rectangles = 100 → 1.334



The number of rectangles = 1000 → 1.333

The approximate value of the integral is approaching the true value depending on the number of rectangles.

Figure 2.9. An example of 'DE'

In Figure 2.8, for example, a student enters a mathematical formula in the input window and then the program immediately shows the area of the curve as a calculator does. The example in Figure 2.9 means that the concept of definite integral is explained by displaying areas of the rectangles and the concept of limit in the program. Figure 2.9 was categorized into 'DE' unlike Figure 2.8 which was suggested as an example of 'DP'. This is because the former showed that a student would make use of the technology as a calculator in finding the values, and they are just focused on the technical role of technology without exploring the concept of definite integral. On the other hand, the latter did not include any kind of students' activities in the activity with technology directly. The teacher would use the example to explain about the concept of definite integral through the demonstration for the whole class. For the reasons, we categorized the examples as 'DP' and 'DE'.

Additionally, there were a few activities of 'E-C-V' in the senior secondary textbooks. In the Figure 2.10, for example, students draw the graph of '$y = sin\, x$' by entering the expression into the input window in the program. While changing a point of contact of the graph, they may examine how the tangent line is changed and visualize the derivative. Then they can draw the derivative of '$y = sin\, x$' exactly by using the function 'drawing the graph of a derivative' of the software used, and verify that the derivative is '$y = cos\, x$' by dynamically examining the change of the tangent line. Actually, the fact that the derivative of '$y = sin\, x$' is the function of cosine is one of the most challenging issues for students to understand. All Mathematics Ⅱ textbooks explained the derivative of trigonometric functions algebraically by using various properties of trigonometric functions and limit. That is, when the increment of *y* on the increment of *x*, i.e. 'Δx', is marked with 'Δy',

$$\Delta y = sin(x + \Delta x) - sin\, x = 2\, cos\left(x + \frac{\Delta x}{2}\right) sin\left(\frac{\Delta x}{2}\right)$$

$$\frac{dy}{dx} = \lim_{\Delta x \to 0} \frac{\Delta y}{\Delta x} = \lim_{\Delta x \to 0} \frac{2\cos\left(x + \frac{\Delta x}{2}\right)\sin\left(\frac{\Delta x}{2}\right)}{\Delta x}$$
$$= \lim_{\Delta x \to 0} \cos\left(x + \frac{\Delta x}{2}\right) \cdot \lim_{\Delta x \to 0} \frac{\sin\left(\frac{\Delta x}{2}\right)}{\frac{\Delta x}{2}} = \cos x \cdot 1 = \cos x$$

However, by allowing students to experience the processes like Figure 2.10, they can be provided visualization of seemingly abstract mathematical ideas and actively learn. These activities should be more widely used to encourage students to actively learn mathematics concepts, because they can conjecture and verify the ideas for themselves through exploration

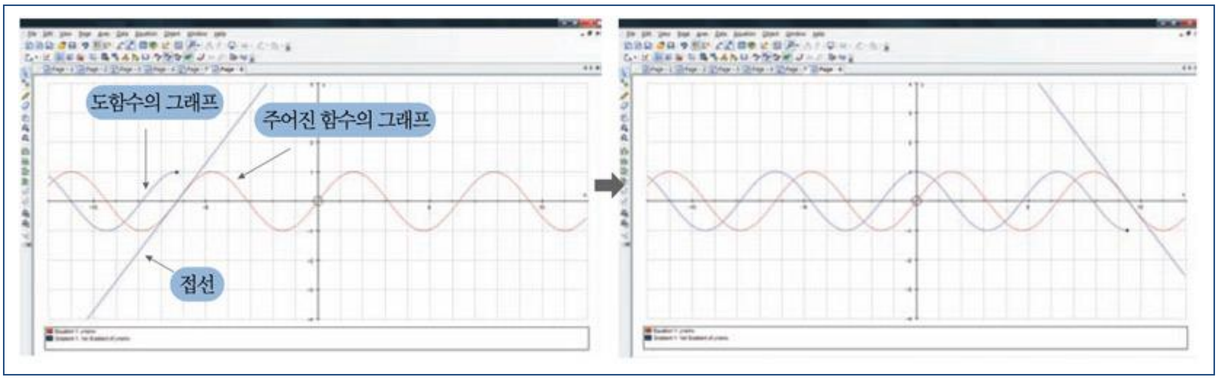
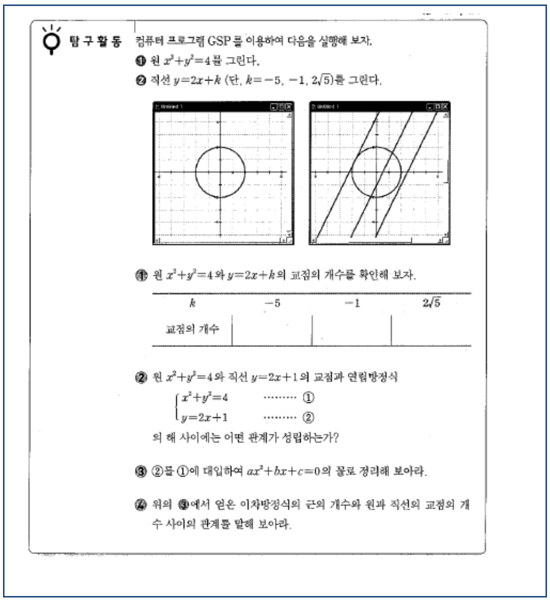


Figure 2.10. An example of 'E-C-V' role of technology

The number of the tasks in which students could try to solve problems through Conjecturing based on Exploring was larger than the junior secondary activities. However, it does not mean that the activities would give students enough and various chances to reflect on their problem solving. It should be noted that all of the activities with technology at the senior secondary levels included only one example for 'Generalizing' or 'extension to new-complex situation' despite the importance of students' ability to generalize mathematical contents. Only one example of 'E-C-V-G' was founded including 'Generalizing' at the senior levels (See Figure 2.11). In the activity, students draw a circle and three lines with technology and find the intersections between the circle and the each line. They will fill the table with the number of intersections between them according to each case. Then the students solve the given simultaneous equations and are asked to guess the relationship between the geometric expressions above the question and the equations. Through the activities, they try to figure out this relationship and verify their conjectures. Finally, the students would be able to find the relations between the numbers of the intersection in between the circle and the lines and one of the roots in the equations. We do not think that the example completely consists of the all kinds of activities including 'Generalizing' or 'extension to new-complex situation'. Contrary to the others examples, however, the activity would provide students with opportunities to figure out relationships between geometry and algebra.



탐구활동 컴퓨터 프로그램 GSP를 이용하여 다음을 실행해 보자.

❶ 원 $x^2+y^2=4$를 그린다.

❷ 직선 $y=2x+k$ (단, $k=-5,\ -1,\ 2\sqrt{5}$)를 그린다.

① 원 $x^2+y^2=4$와 $y=2x+k$의 교점의 개수를 확인해 보자.

k	-5	-1	$2\sqrt{5}$
교점의 개수			

② 원 $x^2+y^2=4$와 직선 $y=2x+1$의 교점과 연립방정식

$$\begin{cases} x^2+y^2=4 & \cdots\cdots\cdots ① \\ y=2x+1 & \cdots\cdots\cdots ② \end{cases}$$

의 해 사이에는 어떤 관계가 성립하는가?

③ ②를 ①에 대입하여 $ax^2+bx+c=0$의 꼴로 정리해 보아라.

④ 위의 ③에서 얻은 이차방정식의 근의 개수와 원과 직선의 교점의 개수 사이의 관계를 말해 보아라.

Figure 2.11. An example of ‘E-C-V-G’ role of technology

The result of this analysis is classified into three major features as the role of technology in Korean secondary mathematics textbooks. First, technology in Korean mathematics textbooks of the senior levels is mainly focused on using it in a technical role more than a conceptual one. The technical role of technology included two types of role like ‘DP’ and ‘DE’. The examples in activities with the technical roles of technology at the textbooks consisted of solving equations according to teacher’s directions or programs’ instruction, finding or computing values of given data and demonstrating mathematical contents. It means that a student does not have an opportunity to explore mathematical contents with technology for him or herself during the class. The students follow instructions of a program or practice using the program during the activity of ‘DP’ without understanding the mathematical meaning. In the case of ‘DE, they look at the screen without conducting activities on their own, as if watching a movie, while the teacher shows the example by his or her manipulation to the whole class. Second, the conceptual role of technology consisted of mainly the use of ‘E’, and the activity of ‘E-V’ was the second largest proportion after ‘E in both Korean junior and the senior secondary mathematics textbooks. The activity of ‘E’ is that the use of technology would offer students opportunity to explore mathematical contents through given materials. Additionally, in the ‘E-V’ activities, students explore a given task according to instructions by the teacher, and then they verify mathematical concepts visually through the exploration without any process of conjecturing the concept for themselves. The crucial advantages of using technology in mathematics education, however, is that technology can provide students with opportunities to foster conjecturing and generalizing during problem solving or understanding of mathematical concepts. According to the analysis, students do not have ample opportunities to conjecture and generalize their thought on mathematical contents while using technology during the class. Thirdly, the examples of students’ activities with technology in the data were mainly focused on the specific strands, such as Geometry and Analysis at the junior and senior levels respectively. Studies on mathematics education with technology showed that technology can help students to explore mathematics in various meaningful ways, thereby improving efficiently in learning mathematics not only in Geometry and Analysis but also in Algebra and Probability & Statistics. However, the activities in Korean secondary mathematics textbooks have not been considered enough in the aspect of developing examples on the mathematics strands except for Geometry and

Analysis. It indicated that technology might be limited to a tool as visualization in teaching and learning Geometry, Functions and Calculus, and others

3. Korean Mathematics Teachers' Concern and Use of Technology

(1) The Stages of Concern and The Levels of Use

The Concern-based Adoption Model (CBAM) was developed to provide "change facilitators with diagnostic tools" (See [14].) to help each individual such as teacher adopt an educational innovation. In particular, [15] noted that the purpose of the CBAM was to "to ease the problems diagnosing group and individual needs during the innovation adoption process". The Model consists of three diagnostic tools, such as the Innovation Configurations (IC), the Stages of Concern (SoC) and the Levels of Use (LoU). The SoC can be used to describe the concerns individuals have as they progress through the innovation process. As shown in the Table 3.1, the SoC consists of 8 types of stages depending on in degree of individual's concern grasped through the Stages of Concern Questionnaire.

Table 3.1: The Stages of Concern on Integrating Technology into Mathematics Classroom

Stage		Description
0	Unconcerned	· The teacher indicates little concern about or involvement with the use of technology in mathematics classroom.
1	Informational	· The teacher indicates a general awareness of the use of technology in mathematics classroom and interest in learning more details about it. · The teacher does not seem too worried about himself or herself in relation to the use of technology in mathematics classroom, such as its general characteristics, effects, and requirements for use.
2	Personal	· The teacher is uncertain about the demands of the use of technology in mathematics classroom, his or her adequacy to meet those demands, and/or his or her role with the use of technology in mathematics classroom. · The teacher is analyzing his or her relationship to the reward structure of the organization, determining his or her part in decision making, and considering potential conflicts with existing structures or personal commitment. Concerns also might involve the financial or status implications of the program for the individual and his or her colleagues.
4	Management	· The teacher focuses on the processes and tasks of the use of technology in mathematics classroom and the best use of information and resources. Issues related to efficiency, organizing, managing, and scheduling dominate.
5	Consequence	· The teacher focuses on the use of technology impact on students' learning mathematics in his or her immediate sphere of influence. · Considerations include the relevance of the use of technology for students' learning mathematics; the evaluation of student outcomes, including performance and competencies; and the changes needed to improve student outcomes.
6	Collaboration	· The teacher focuses on coordinating and cooperating with other teachers regarding the use of technology in mathematics classroom.
7	Refocusing	· The teacher focuses on exploring ways to reap more universal benefits from the use of technology in mathematics classroom, including the possibility of making major changes to it or replacing it with a more powerful alternative.

The LoU describes each individual's current implementation state of technology and includes 8 kinds of levels of technology use and adopting innovation. (See Table 3.2). The levels can be assessed based on personal or group interview, and observation or questionnaire.

Table 3.2: The Levels of Technology-Use in Mathematics Classroom

Level		Description
0	Nonuse	· No action is being taken with respect to the use of technology in mathematics classroom.
Ⅰ	Orientation	· The teacher is seeking out information about the use of technology in mathematics classroom.
Ⅱ	Preparation	· The teacher is preparing for the use of technology in mathematics classroom for the first time.
Ⅲ	Mechanical Use	· The teacher is using technology in mathematics classroom through a poorly coordinated manner and is making teacher-oriented changes.
ⅣA	Routine	· The teacher is making few or no changes and has an established pattern of use.
ⅣB	Refinement	· The teacher changes the use of technology in mathematics classroom to suit his or her needs.
Ⅴ	Integration	· The teacher is making deliberate efforts to coordinate with other teachers in using technology in mathematics classroom.
Ⅵ	Renewal	· The teacher is seeking more effective alternatives to the established use of technology in mathematics classroom.

(2) Korean Teachers' Concern and Use of Technology

The sample of this study was taken from Korean mathematics teachers at secondary levels. Among 16 cities and provincial secondary schools, we collected data from each 16 junior and senior secondary schools. The total 236 participants were involved in the study, comprised of 75 (32%) taught in junior secondary schools and 161 (68%) taught in senior secondary schools.

Korean Teachers' Concern on Integrating Technology into Mathematics Classroom

The teachers were asked to complete SoCQ which consisted of 35 statements expressing a level of concern about using technology in mathematics classrooms. Participants marked an 8-point Likert-type scale indicating the degree to which each concern was in concordance with their current states or opinions about technology in mathematics education. Scores had a range of 0-35 for each Stages of Concern. A raw score for each stage was calculated by adding the five items that were included at the stage and converted into percentile scores. For this analysis, we made use of data which included the highest and second-highest Stages of Concern.

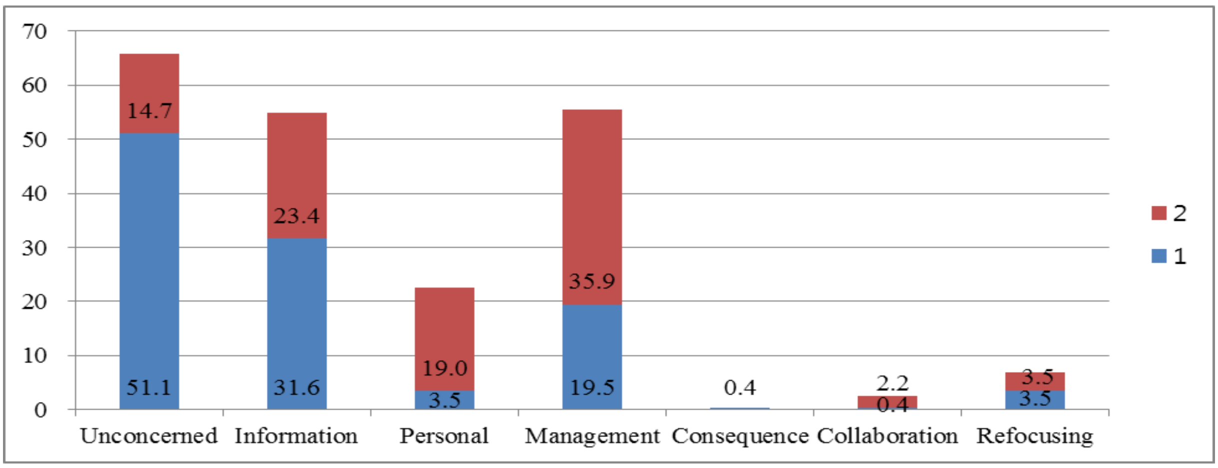


Figure 3.1. The Stages of Concern on using Technology in Mathematics Classroom

In the above Figure 3.1, the highest peak Stage of Concern was the Unconcerned Stage (Stage 0) with 51.1% of the respondents having this stage as their peak stage. It did not mean that the teachers are concerned little about or involved little with the use of technology in teaching mathematics. Through analysis of each item at Stage 0, it was proven that they would like to teach mathematics with other teaching methods. The result of this analysis showed that the teachers do not seem to feel the need to use technology in mathematics classroom at the moment. According to the data, Personal Concern (Stage 2) displayed a relatively low level of concern, compared to Information (Stage 1) or Management Concern (Stage 3). It means the teachers felt no personal threat of their professional status or role when they consider the needs of using technology in mathematics classroom. Respondents with high Stage 1 and low Stage 2 are generally open to and interested in technology. The data showed teaching mathematics with technology in Korea is in its early phase. Studies about concerns on technology or innovation also showed similar results like this study- Korea at the beginning stage of innovation. There is another point which claims our attention. Unlike the studies, Korean mathematics teachers need more information about how to use technology and have interest in learning more details about it, even though they have already made use of technology in their classes (See Figure 3.2). Additionally, they had a high level of Management Concern on using technology. The teachers are concerned about not having enough time to prepare lessons including technology and spending time with nonacademic problems related to technology. In other words, they have already considered actual situations when they teach mathematics using technology in their classrooms. Management Concern generally marked the middle or late phase of innovation. The result of this study, on the other hand, showed that Korean mathematics teachers' Concern on using technology is at between the early and the middle phase of innovation.

Korean Teachers' Use of Technology in Mathematics Classroom

The data about teachers' current levels of technology use were collected from questionnaire, including self-rating of the ability to integrate technology in their present teaching mathematics. The questionnaire was based on [16] and modified through two pilot tests which had been compared with both the results of questionnaire and individuals' interview. Participants filled out the survey to describe the current state of using technology in mathematics classroom. The levels of using technology, like the Table 3.2, were categorized into eight degrees which were differentiated based on the participants' answers. The results are listed below at Figure 3.2.

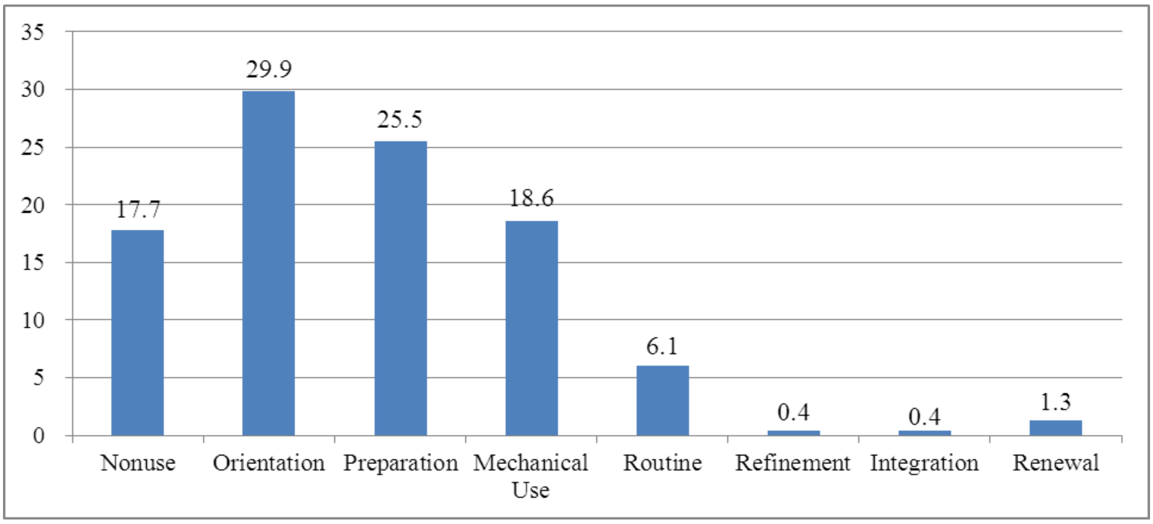


Figure 3.2. The Levels of Use of Technology in Mathematics Classroom

More than half of the respondents have decided to make use of technology in mathematics classroom or already applied technology to their teaching mathematics. According to [17], a teacher is able to continue using innovation when he or she is at least beyond the level of Mechanical Use. It means that about 27% of Korean mathematics teachers had the ability to make use of technology in practice and 26% of the participants would like to use technology in teaching mathematics in the near future. Analyzing technology-use data with Concern data can lead to accelerate technology use of technology in mathematics classrooms through individualized interventions or supports. Korean mathematics teachers need information beyond how to use technology as technical functions. They need support to effectively make use of it in mathematics lessons, building their own experiences on adopting and inviting technology into the classroom.

4. Conclusion

In this paper we attempted to illustrate some of the implications arising from the analysis of the role of technology in Korean secondary mathematics textbooks and the survey on Korean mathematics teachers' concern on and levels of using technology in mathematics classroom. Through the analysis of data, we found that mathematics teachers need more proper information and support to integrate technology into teaching mathematics. Therefore, it is concluded that educational researchers or administrators need to help teachers move toward more practical use of technology without emotional or physical barriers in mathematics classroom.

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