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Korean Teachers' Perception of Future Education after COVID-19 and Direction of Technology Education

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Abstract: This study was conducted to predict changes in education after COVID-19 through a survey of Korean teachers' perceptions of future education and to set the future direction of technology education based on this. To this end, in this study, by analyzing the educational situation after the COVID-19 crisis, five major categories were defined: "Educational Goals", "Curriculum", "Teachers' Competencies", "School Education System", and "Education System for Pre-service Teachers". A total of 465 people participated in the survey from 16 cities and provinces in the Republic of Korea from February to May 2021 and responded to 16 questions according to the topic and using the online survey tool. As a result of the survey, Korean teachers responded that "adaptation to new technology" and "pursuit of social values" need to be emphasized as educational goals after COVID-19, and "individualized distance education" and "project-based learning" need to be actively applied in curriculum operation. They thought that teachers would be required to have competencies such as "technology literacy" and "creating learning affordances". In addition, in school education, "interdisciplinary integration" and "safety and health education" must be emphasized, and the teachers answered that it is important to learn social values. In the course of training pre-service teachers, it was considered necessary to expand convergence and complex courses and to actively apply blended learning, deeper learning, and crossover learning. Based on this, the direction of future technology education can be established. For the development of technology education, it is necessary to change competencies from problem-solving to concept design, metaverse-based technology education needs to be conducted, and technology ethics need to be treated importantly.

Keywords: COVID-19, Korean teachers, Future education, Technology education, Research

1. Introduction

Many aspects of people's lives have changed since the COVID-19 outbreak. This is not limited to specific fields, but rather all aspects such as economy, culture, and society. The field of education is no exception to the changes induced in the COVID-19 era. Since the COVID-19 crisis, school sites, teachers, and students are experiencing more changes than ever before. In particular, the full implementation of non-face-to-face classes requires a total change in the education's structure in the form, content, and method of classes. In February 2020, when the infectious disease crisis alert entered the "severe" stage as the influx and spread of COVID-19 in the Republic of Korea accelerated, the Ministry of Education of Korea postponed the opening of school. The opening of universities and face-to-face classes were completely banned. In March 2020, an unprecedented "online" school was announced sequentially according to school level and grade. Even when COVID-19 is over, it is difficult to go back to the pre-COVID-19 era. In other words, we have reached a paradigm shift in education with the outbreak of COVID-19. The changes to education welcomed in this era have great implications for the future of the field of education.

Non-face-to-face class is not a temporary phenomenon but rather a new path for Korean education in the so-called "new normal" era. Now, in the era of non-face-to-face education, we need to achieve new educational innovation with a completely new paradigm. Methodologies for educational innovation in Korea are diverse including technology-oriented edu-tech and video conferencing applications such as "Web-Ex", and "Zoom". Face-to-face and non-face-to-face class content development are equally as important, respectively various solutions have been proposed.

In addition to these solutions, we investigated the perceptions of Korean teachers on how education has changed after COVID-19. Through the results of this study, it is possible to predict the method of education innovation in Korea after COVID-19 and to

compare Korea's solutions with cases from various countries around the world. The research questions to achieve the purpose of this study are as follows.

- (1) What are the teacher's perceptions of future educational goals after COVID-19?
Education goals after COVID-19 are on a completely different level than they were previously. The most important goal of education in Korea so far has been to nurture healthy citizens of a democratic society. However, this view is expected to change after COVID-19. A new educational agenda is expected to be formed for overcoming global crises like climate change and epidemics.
- (2) What are the teacher's perceptions of the direction of the future curriculum after COVID-19?
The curriculum plays a practical role in driving education. Therefore, the survey on the perception of the direction of the curriculum after COVID-19 enables us to predict the direction in which education in Korea will flow in the future.
- (3) What are teachers' perceptions of teacher competency after COVID-19?
Competence has been an important topic in education for a long time. Discussion of competence is currently the present, not the future, of education in Korea. Therefore, examining what is emphasized as teacher competency after COVID-19 is also a key factor of this study.
- (4) What are the teacher's perceptions of the school education system after COVID-19?
The Korean school education system is notorious for "Injected education" and "Competition-oriented education". It was true that the school education system was considered rigid because it stayed in a fixed frame. However, with the sudden introduction of COVID-19 remote classes, Korea's school education has undergone many changes. Therefore, in this study, the related contents were investigated.
- (5) What are teachers' perceptions of the direction of the teacher education system after COVID-19?
As COVID-19 is changing the education paradigm in Korea, the teacher education system is also a key to the paradigm change. It is also investigated how the Korean teacher education system will change after COVID-19.

2. Materials and Methods

In this study, a three-phase research method was applied as shown in Fig. 1 to investigate the perception of pre-service teachers on education after COVID-19.

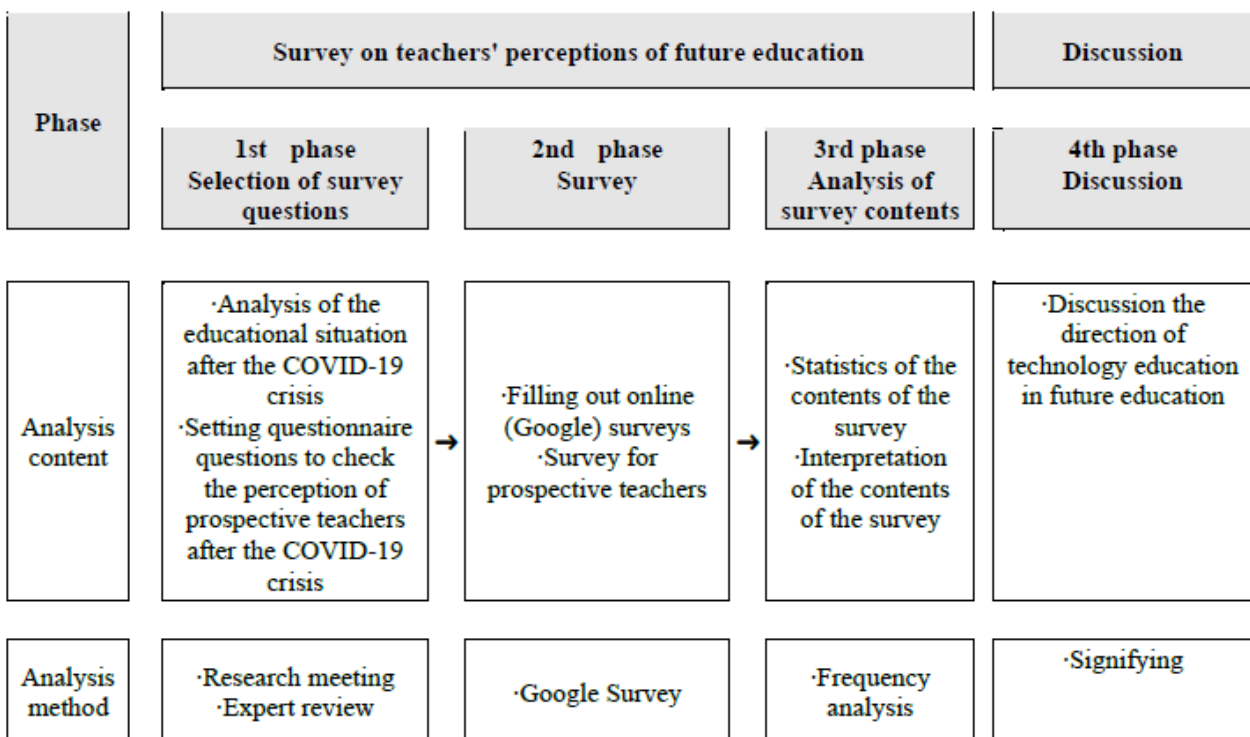


Fig. 1. Research method.

2.1. Questionnaire

In this study, a questionnaire was developed under five main themes: educational goals, curriculum, teachers' competencies, school education system, and pre-service teacher education system. During the development, the educational situation after the COVID-19 was analyzed through the review of previous studies. Each topic was selected based on this, and then the questionnaire was developed after consultation with the research team.

Table 1. Questionnaire contents

Survey topic	Questions
Educational goals	How do you predict the future education ecosystem will change after COVID-19?
	What do you think are the skills needed to live in a future society after COVID-19?
	What do you think would be appropriate as the focus of primary education changes after COVID-19?
	What values do you think our education should focus on after COVID-19?
Direction of the curriculum	How do you predict the educational form will change in the operation of the curriculum after COVID-19?
	How do you predict the teaching/learning method (class method) will change after COVID-19?
	How do you predict the evaluation method will change in the operation of the curriculum after COVID-19?
Changes in teacher competency	Do you think there will be a change in the competencies that teachers should have after COVID-19?
	What do you think are the teacher's person-oriented competencies that will be most emphasized after COVID-19?
	What do you think are the teacher's class-oriented competencies that will be most emphasized after COVID-19?
Direction of the school education system	What do you think is the subject group that is being emphasized after COVID-19?
	What do you think is the most important cross-curricular topic after COVID-19?
	If the school system is reorganized after COVID-19, what form do you think is desirable?
	Write down the three most important keywords in our education after COVID-19.
Direction of the pre-service teacher education system	What do you think should be emphasized in the teacher training stage after COVID-19?
	What type of class do you think is desirable for teacher training institutes after COVID-19?

2.2. Survey

For the survey, Google Drive (<https://drive.google.com/>) was used, which was conducted from March 01 to 20, 2021. The subjects of the survey were teachers from 16 cities and provinces in the Republic of Korea (Seoul, Gyeonggi, Incheon, Chungnam, Chungbuk, Sejong, Daejeon, Gyeongbuk, Gyeongnam, Daegu, Ulsan, Busan, Jeonbuk, Jeonnam, Gwangju, and Jeju), and a total of 465 respondents responded. The responses to the questionnaire were analyzed using MS Excel. In the frequency analysis, the perception was analyzed with questions about future education goals, curriculum, teacher competency, school education system, and pre-service teacher education system after COVID-19.

Based on the results of the survey on teachers' perceptions of future education after COVID-19, the future direction of technology education was discussed. The discussion was made based on what was important in the survey of teachers' perceptions of future education after COVID-19. Such discussions provide an important reference for technology education to overcome a crisis if a pandemic such as COVID-19 is to come again.

3. Results

3.1. Teachers' Perception of Education after COVID-19

In the early days of COVID-19, several studies were conducted in Korea to examine the relationship between COVID-19 and education (Go, Choi, Hwang, and Gil 2020; Lee 2020; Han and Sim 2020). Among several studies, Go et al. (2020) conducted a study to investigate the perceptions of Korean pre-service teachers on future education after COVID-19. Pre-service teachers are the main characters to lead future education and the perception of pre-service teachers provides an important reference in designing future education. This study was carried out as a follow-up study of Go et al.'s (2020), and the future direction of technology education was established by examining teachers' perceptions. Pre-service teachers' perception of future education is an important reference in analyzing teachers' perceptions. For this reason, in this study, the results of the previous study by Go et al. (2020) are summarized and presented as follows.

Table 2. Pre-service teachers' perceptions of changes in educational goals after COVID-19

	Number of Responses	%
An educational ecosystem that adapts to changes in science and technology	188	55.9
An educational ecosystem that pursues individual quality of life	79	23.5
An educational ecosystem where everyone lives together	53	15.8
An educational ecosystem that respects human beings	16	4.8
Total	336	100

When we asked about the future education ecosystem after COVID-19, 55.9% (n=188) of the respondents chose “an educational ecosystem that adapts to changes in science and technology” as important. 23.5% (n=79) selected “an educational ecosystem that pursues individual quality of life”, and 15.8% (n=53) chose “an educational ecosystem where everyone lives together”. Because of COVID-19, the use of information and communication technology has become common in everyday life, and education needs to be aimed at cultivating the ability of students. In addition, as time spent indoors increases, pre-service teachers believe that education must be provided to improve the quality of life of students at home.

Table 3. Pre-service teachers' perceptions of Education System after COVID-19

	Number of Responses	%
Increasing the number of small size classes in school	150	44.0
Expansion of project-based learning linking school and home	121	35.5
Intensification of homeschooling due to de-schooling	44	12.9
Home study using public education broadcast	24	7.0
Others	2	0.6
Total	341	100.0

For the question about the educational form in the operation of the curriculum after COVID-19, 44% (n=150) of the respondents selected “increasing the number of small size classes in school” to be important, 35.5% chose “expansion of project-based learning linking school and home”, 12.9% (n=44) selected “strengthening de-schooling and homeschooling”, and 7% (n=24) chose “home study using public education broadcast”. Pre-service teachers recognized that the number of students in a class needs to be reduced and educational activities at school and home must be linked to reduce the risk of infection at school.

Table 4. Pre-service teachers' perceptions of Teachers' Competencies after COVID-19

	Number of Responses	%
Technology literacy	184	54.0

Problem-solving	67	19.6
Ethicality	53	15.5
Creativity	19	5.6
Social skill	15	4.4
Others.	3	0.9
Total	341	100.0

For the question of whether teachers' competencies must be most emphasized after COVID-19, 54.0% (n=184) of the respondents chose "technology literacy", 19.6% (n=67) selected "problem solving", and 15.5% (n=53) selected "ethicality". Pre-service teachers must be able to create high-quality online content to adapt to the current educational environment where online education is the common norm due to COVID-19. In addition, teachers must-have "technology literacy" so that they can communicate with students online and conduct educational activities smoothly.

Table 5. Pre-service teachers' perceptions of Emphasized Subjects after COVID-19

	Number of Responses	%
Integrated subjects	199	58.4
Science/Practical Arts	131	38.4
Social studies/Moral Education	74	27.6
Creative experience activities	83	24.3
Physical Education	42	12.3
Korean	26	7.6
English	26	7.6
Mathematics	24	7.0
Music/Art	20	5.9
Other	8	2.4
Total	633	

For the question of 'what subject/group of subjects is emphasized after COVID-19', 58.4% (n=199) of the respondents selected "integrated subjects", 38.4% (n=131) chose "science/practical arts", 27.6% (n=74) chose "Social studies/Moral Education", 24.3% (n=83) selected "Creative experience activities", and 12.3% (n=43) selected "Physical Education". Pre-service teachers thought that the integration between subjects needs to be expanded more than now, and activities that emphasize healthy life in science/practical arts and social/ethics subjects must be conducted.

To summarize the perception of prospective teachers for future education, the educational solution in COVID-19 is based on technological innovation. Pre-service teachers recognized that they adapt to the information technology-based non-face-to-face educational environment when they educate on technology literacy. Such education is conducted with the decreasing number of students in a class within the school, and the integration between subjects needs to be emphasized more than before. Lastly, in a society where daily life is threatened by COVID-19 and a sense of crisis prevails, social values such as safety, cooperation, consideration, and diversity are recognized as important topics in future education.

3.2. Analysis of Changes in Education after COVID-19

After COVID-19, many countries are educating students online using EdTech instead of face-to-face classes. Many countries are providing educational content on public radios and televisions and continuous education services through blended learning by

using online education platforms (Flores and Gago, 2020; Radha, Mahalakshmi, Kumar, and Saravanakumar, 2020; Winter, Costello, O’Brien, and Hickey, 2021). Countries have also rented out tablets and laptops to help students access online educational content. These policies are adopted regardless of the continent, culture, or level of development. In countries with higher levels of development or higher IT capabilities, however, more and better online content is provided on better learning platforms (Rodriguez, M. B., Cobo, C., Munoz-Najar, A., and Ciarrusta, I. S., 2021).

Germany has been building a digital-based education system by running a long-term project called “eEducation” to digitize education in grades 1 to 10. They have selected a model digital school as a model and continue to promote the digitization of education. The online platform “Lernraum Berlin” is the result of Germany’s digitization project. “Lernraum Berlin” is a learning management system used in all public schools. Teachers use this platform to conduct online classes. “Lernraum Berlin” includes various functions such as registration of lecture content, the design of learning activities such as discussion, sharing of learning materials, management of class schedule (calendar), management of learning history, and evaluation (Senatsverwaltung für Bildung, Jugend und Familie, 2020). New York City, USA, provides detailed information on distance learning in the “Learn at Home” section of the Department of Education website. New York City offers distance learning as an alternative to face-to-face classes in schools that are exploring ways to provide appropriate feedback on homework and projects as well as evaluation methods in distance learning (The New York City Department of Education, 2020). In Singapore, the Ministry of Education is operating an online learning management system (LMS) called “Singapore Student Learning Space” to help with home-based learning. They provide distance education content in major subjects such as English, science, history, social studies, and mathematics in “SSLS”, by using distance education platforms such as “Google Classroom” or “Zoom”. “SSLS” provides content that students can learn according to their level/learning progress and provides learning materials in various fields according to students' interests (Ministry of Education Singapore, 2021). The UK is supporting national-level distance education with a platform called “Key for School Leaders”. “Key for School Leaders” provides operation methods, function comparisons, and case studies of each platform so that schools can use various distance education platforms. Additionally, the BBC, a public broadcaster, provides various free video lectures on major subjects such as English and mathematics for all age groups. The UK is also using various digital teaching materials providing platforms such as “Oak National Academy” and “White Rose Math” (GOV.UK, 2020). In Japan, various online learning materials are available free of charge by central government ministries, local governments, offices of education, schools, and private organizations. In particular, each regional office of education is trying to provide home-based learning programs and learning materials for free on the learning portal. Additionally, the central Ministry of Education, Culture, Sports, Science, and Technology has also opened a “Children’s Learning Support Site” (Ministry of Education, Culture, Sport, Science and Technology Japan, 2020).

Table 6. Educational Policies in Response to COVID-19 in Major Countries

	German	USA	UK	Singapore	Japan
Platform	Lernraum Berlin	Learn at Home	Key for School Leaders	SSLS	Child learning support site
Support Policy	“Learning Bridges”, is an educational support program for students with low access to resources such as those who do not have a PC or have limited Internet access, is in operation. Educational programs for students with low access to technology for distance learning are provided by telephone, visits, and delivery of	Internet-enabled devices (iPad) are rented to enable distance education. About 175,000 devices were distributed to schools before distance education began, and a total of 310,000 devices have been provided to date.	The Ministry of Education is providing digital devices (Laptops and tablets) and Internet access to schools and economically marginalized children to support distance learning.	About 12,500 tablets and about 200 dongles (broadband internet wireless adapters) are provided for smooth internet use, and a telecommunication company (StarHub) is providing unlimited broadband communication services to students from low-income families.	Send a list of information that can be learned directly from a PC Support for home study using groupware Learning, HR, individual guidance using ICT

learning aids to mailboxes. 9200 tablets are distributed to schools for the economically marginalized.

Online schooling refers to the operation of the school curriculum with all classes being conducted remotely without face-to-face contact between teachers and students. Schools at each level operate regular classes remotely using a public online learning platform under the Ministry of Education's "remote class operation standards". The public broadcaster, Korea Educational Broadcasting System (EBS) provided special lectures on TV and YouTube and provided online learning content free of charge (Ministry of Education Republic of Korea, 2020a).

4. Teachers' Perceptions of Post-COVID-19 Education

4.1 Educational Goals after COVID-19

The questionnaire on educational goals after COVID-19 consists of a total of 4 questions (Table 7). Participants responded to the educational ecosystem, ability, focus of change, and values, and based on this, educational goals recognized by teachers were derived.

Table 7. Teachers' perceptions of educational goals after COVID-19

Question	Options	Number (%)
How do you predict the future ecosystem will change after COVID-19?	It will be an educational ecosystem that adapts to changes in science and technology	199 (42.8%)
	It will be an educational ecosystem that seeks to improve the education quality of life for each person	156 (33.5%)
	It will be an educational ecosystem that everyone coexists in	78 (16.8%)
	It will be an educational ecosystem that advocates respect for human beings	28 (6.0%)
	Others	3 (0.6%)
What do you think are the skills needed to live in a future society after COVID-19?	Empathy, communication, and cooperation	313 (67.3%)
	Mastery of new technologies	189 (40.6%)
	Creative thinking	149 (32.0%)
	Interest in and participating in social issues	143 (30.8%)
	Following rules and orders	92 (19.8%)
	Confidence, curiosity, and challenges	86 (18.5%)
	Enjoyment of culture and art	28 (6.0%)
What do you think is appropriate as the focus of primary education change after COVID-19?	Emphasis on collaboration with others	191 (41.1%)
	Reinforcement of information and communication education and technology education	187 (40.2%)
	Pursuing education that is closely related to real life	179 (38.5%)
	Education that connects life inside and outside of school	176 (37.8%)
	Considering each student's dreams and individuality	167 (35.9%)
	Helping students overcome adverse family circumstances	157 (33.8%)
	Strengthening humanities and social education	63 (13.5%)
Reinforcement of school-centered education	29 (6.2%)	
Enhancement of national competitiveness	25 (5.4%)	
Education that gives more support to the capable people	10 (2.2%)	

	Education focused on theory and discipline	7(1.5%)
	Excellence education through competition	4(0.9%)
What do you think our education should focus on values after COVID-19?	Human dignity	278(59.8%)
	Cooperation	278(59.8%)
	Diversity	192(41.3%)
	Autonomy	155(33.3%)
	Ecological environment	151(32.5%)
	Publicity	118(25.4%)
	Democracy	54(11.6%)
	Equality	50(10.8%)
	Excellence	26(5.6%)
	Competition	10(2.2%)

For the question of ‘how the future educational ecosystem will change after COVID-19’, 42.8% (n=199) of the respondents answered that it will be an educational ecosystem that adapts to changes in science and technology, 33.5% (n=156) answered that it will become an educational ecosystem that seeks to improve the quality of life for each person, and 16.8% (n=78) replied that it will become an educational ecosystem that everyone coexists in. When asked about the ability to live in a future society after COVID-19, 67.3% (n=313) answered “empathy, communication, and cooperation” are necessary, 40.6% (n=189) answered “mastery of new technologies”, 32.0% (n=149) answered "creative thinking", and 30.8% (n=143) answered "interest in and participate in social issues" to be important. When asked about the focus on changes in primary education after COVID-19, 41.1% (n=191) thought “emphasis on collaboration with others” to be a focus, 40.2% (n=187) selected “reinforcement of information and communication education and technology education”, 38.5% (n=179) selected “pursuing education that is closely related to real-life”, and 37.8% (n=176) selected “education that connects inside and outside of school” to be a priority. 35.9% (n=167) chose “considering each student's dreams and individuality”, and 33.8% (n=157) chose “helping students overcome adverse family circumstances.” When asked about the value of education after COVID-19, 59.8% (n=278) answered “human dignity” is important, 41.3% (n=192), 33.3% (n=155), 32.5% (n=151), and 25.4% (n=118) chose “Cooperation”, “Diversity”, “Autonomy”, “Ecological environment”, and “Publicity” as an important value, respectively.

In summary, teachers recognized that adapting to new technologies and pursuing social values were appropriate as the key goals of education after COVID-19. Teachers predicted that education after COVID-19 would change according to the development of science and technology, and in this educational ecosystem, mastery of new technologies and reinforcement of information and communication technology education would be important. In addition, teachers selected empathy, communication, and cooperation as necessary skills to live in a future society after COVID-19, and thought that cooperation should be the primary focus of education after the pandemic. This shows that teachers recognized how social values are more important in education after COVID-19.

These teachers' perceptions are consistent with those of pre-service teachers. Teachers and pre-service teachers agreed that it is necessary to adapt to changes in science and technology, and that empathy, communication, and cooperation are necessary to live in a future society (Go et al., 2020). Therefore, primary education needs to focus on technology education and encourage cooperation. In addition, pre-service teachers and teachers selected "human dignity" as a value to be emphasized in education, which sympathizes with the need for technology education while the philosophy of human dignity needs to be supported from the bottom. While teachers agree on the need for technological education, they recognize that the spirit of human dignity supports it.

4.2 Direction of Curriculum Operation after COVID-19

Table 8 shows teachers' perceptions about the direction of the operation of the curriculum after COVID-19. Each question asked about the direction of the educational process perceived by teachers, focusing on educational types, teaching and learning methods, and evaluation methods.

Table 8. Teachers' perceptions of the direction of the operation of the curriculum after COVID-19

Question	Options	Number(%)
How do you predict the educational form will change in	Expansion of project-based learning linking school and home	198 (42.6%)
	Increasing the number of small size classes in school	179 (38.5%)

the operation of the curriculum after COVID-19?	Intensification of homeschooling due to de-schooling	78 (16.8%)
	Home study using public education broadcast	7 (1.5%)
	Others	2 (0.4%)
How do you predict the teaching/learning method (class method) will change after COVID-19?	Invigoration of remote classes through tools such as zoom	230 (49.5%)
	Reinforcement of individualized classes in the form of packages such as module learning	142 (30.5%)
	Emphasis on collaboration and collaboration-oriented instruction	63 (13.5%)
	Teacher-centered lecture class as before	27 (5.8%)
	Others	3 (0.6%)
How do you predict the evaluation method will change in the operation of the curriculum after COVID-19?	Evaluation of each student's portfolio	304 (65.4%)
	Expansion of online paper-based evaluation	55 (11.8%)
	Expansion of online oral evaluation	54 (11.6%)
	Maintain the current performance evaluation method	47 (10.1%)
	Others	5 (1.0%)

Regarding the type of education to be changed, 42.6% (n=198) chose "expansion of project-based learning linking school and home", 38.5% (n=179) chose "increasing the number of small size classes in school", and 16.8% (n=78) chose "intensification of homeschooling according to de-schooling" as an important change. When asked about teaching and learning methods to be applied to curriculum operation, 49.5% (n=230), 30.5% (n=142), and 13.5% (n=63) selected "emphasis on collaboration and collaboration-oriented instruction", "reinforcement of individualized classes in the form of packages such as module learning", and "invigoration of remote classes through tools such as zoom" as a prioritized method, respectively. Regarding the evaluation method of education, 65.4% (n=304) 11.8% (n=55) 11.6% (n=54) 10.1% (n=47) selected "evaluation of each student's portfolio", "expansion of online paper-based evaluation", "expansion of online oral evaluation", and "maintaining the current performance evaluation method" to be an important method.

The change in the direction of the curriculum operation perceived by teachers after COVID-19 can be explained by "individualized distance education" and "activation of project learning". The COVID-19 pandemic has brought distance learning to classes in a short period without preparation. In distance learning, it is easy for the teacher to provide different content according to the needs of each student, and it is easy for students to find and learn the educational content that is suitable for them. In particular, contemporary students are the generation called "digital natives" and seamlessly adapt themselves to distance education using digital technology. Therefore, teachers thought that remote and individualized classes need to be strengthened after COVID-19.

Teachers recognized that project-based learning is an appropriate teaching-learning method for future education as project-based learning helps students immerse themselves in a distance learning situation where students can learn on their own. These changes in teaching and learning methods result in changes in evaluation methods. Individualized distance education leads to individualized assessment tailored to the individual student, and in project-based learning, portfolios is used to evaluate the process and results of activities comprehensively.

There are no significant changes in "individualized distance education" and "project learning" which are emphasized even before COVID-19. However, after COVID-19, changes accelerated rapidly. In particular, the current education situation in Korea is restricted in terms of the number of face-to-face personnel and is actively implemented in interactive distance learning. Similar perceptions have also appeared in a study of pre-service teachers (Go et al., 2020), and the tendency is more pronounced for teachers. In particular, more respondents expected portfolio expansion in this teacher group. This is interpreted that teachers who have a better understanding of the classroom situation evaluate the portfolio as an appropriate and individualized method in the current school evaluation system for performance evaluation.

4.3 Changed Competencies of Teachers after COVID-19

The questionnaire survey to examine teachers' perceptions of changes in the competencies required of teachers after COVID-19 consisted of 3 questions (Table 9). The questions asked teachers' thoughts on whether or not teachers' competencies will change in future education and how the future of teachers' competencies will be changed to understand person-oriented competencies and class-oriented competencies.

Table 9. Teachers' perceptions of changes in teacher's competencies after COVID-19

Question	Options	Number (%)
Do you think there will be changes in the competencies that teachers should have after COVID-19?	There will be changes.	450 (96.8%)
	There will be no changes from before.	15 (3.2%)
What do you think are the teacher's person-oriented competencies that will be most emphasized after COVID-19?	Technology literacy	216 (46.5%)
	Problem-solving	102 (21.9%)
	Ethicality	67 (14.4%)
	Social skill	40 (8.6%)
	Creativity	38 (8.2%)
	Others.	2 (0.4%)
What do you think will be the most important teacher's class-oriented competencies that should be emphasized after COVID-19?	Creating learning affordances	205 (44.1%)
	Building relationships with learners	124 (26.7%)
	Lesson design and development	115 (24.7%)
	External Cooperation / Performance Management	13 (2.8%)
	Expertise in Pedagogical Content Knowledge	8 (1.7%)

To the question asking whether the competencies required of teachers will change after COVID-19, 96.8% (n=450) answered that there will be changes. 3.2% (n=15) replied that there will be no changes from before. As for the person-oriented competencies required of teachers after COVID-19, 46.5% (n=216), 21.9% (n=102), and 14.4% (n= 67) of the respondents chose “technology literacy”, “problem-solving”, and "ethicality" as important competences. Regarding the class-oriented competencies that will be most emphasized for teachers after COVID-19, “creating learning affordance”, “building relationships with learners”, and "lesson design and development" were selected by 44.1% (n=205), 26.7% (n=124), and 24.7% (n=115) of the respondents as important competencies.

The competencies of future teachers recognized by teachers after COVID-19 are described as “technology literacy” and “learning affordance”. Although it is difficult to teach students face-to-face in the educational field after COVID-19, various class materials can be utilized by using advanced digital technology. Therefore, the ability to compose learning materials and environments is emphasized to help students participate in individualized learning.

Regarding changes in education after COVID-19, both teachers and pre-service teachers had the same view that technology literacy and the ability need to be emphasized to create learning affordances (Go et al., 2020). This suggests that the two groups share the same perception that the form of education after COVID-19 is diversifying from traditional face-to-face classes to non-face-to-face and remote classes by using communication technology. In other words, the ability to freely handle information, communication devices, and software is required for both teachers and students in remote classes after COVID-19. The ability to create an environment in which students actively participate and immerse themselves in learning has become important in a situation where they cannot learn in a fixed place such as school and have to learn on their own in their living space.

4.4 Operation of School Education System after COVID-19

As shown in Table 10, the questions about changes in teachers' perceptions and the direction of operation of the school education system after COVID-19 consisted of a total of 4 questions (Table 10). Each question asked about the teacher's perception of the subject and the cross-curricular theme and system reform emphasized in future school education. In addition, the main keywords in education after COVID-19 were derived.

Table 10. Teachers' perceptions of the direction of operation of the school education system after COVID-19

Question	Options	Number (%)
Which subject/group of subjects will be emphasized after COVID-19?	Integrated subjects	273 (58.7%)
	Science/Practical Arts	134 (28.8%)
	Creative experience activities	84 (18.1%)

	Korean	82 (17.6%)
	Mathematics	79 (17.0%)
	Social studies/Moral Education	68 (14.6%)
	Physical Education	40 (8.6%)
	English	35 (7.5%)
	Music/Art	30 (6.5%)
	Other	9 (1.9%)
What do you think are the most important Cross-curricular themes after COVID-19?	Safety Education, Health Education	241 (51.8%)
	Character Education	193 (41.5%)
	Environment/ Education for Sustainable Development	187 (40.2%)
	Democratic Citizenship Education	131 (28.2%)
	Career Education	95 (20.4%)
	Human Rights Education	87 (18.7%)
	Economics-Financial Education	47 (10.1%)
	Multicultural Education	18 (3.9%)
	Unification education	3 (0.6%)
	Dokdo Education	3 (0.6%)
	Others	15 (3.2%)
If the school system is reorganized after COVID-19, what form do you think would be desirable?	Grade 1 ~ Grade 6(current interdisciplinary)	255 (54.8%)
	Grades Clusters(Gr-Gr2, Gr3-Gr4, Gr5-Gr6)	110 (23.7%)
	Grade 1 ~ Grade 5	46 (9.9%)
	Admission to a higher school with a qualification test instead of the school system	45 (9.7%)
	Others	8 (1.7%)
Which teacher class-oriented competencies will be most emphasized after COVID-19?	Cooperation	83 (17.8%)
	Safety	76 (16.3%)
	Communication	66 (14.2%)
	Character	51 (11.0%)
	Creativity	44 (9.5%)
	Health	44 (9.5%)
	Autonomy	44 (9.5%)
	Environment	43 (9.2%)
	Consideration	33 (7.1%)
Education	19 (4.1%)	

For the question of which subject/group of subjects will be emphasized after COVID-19, 58.7% (n=273), 28.8% (n=134), 8.4% (n=18.1), 17.6% (n=82), 17.0% (n=79), and 14.6% (n=68) selected “integrated subjects”, “science/practical arts”, “creative experience activities”, “Korean”, “Mathematics”, and “social studies/moral education” as important subjects, respectively. When asked about the most important cross-curricular themes after COVID-19, 51.8% (n=241), 41.5% (n=193), 40.2% (n=187), 28.2% (n=131), 20.4% (n=95), 18.7% (n=87), and 10.1% (n=47) chose the theme as “safety education, health education”, “character education”, “environment/education for sustainable development”, “democratic citizenship education”, “career education”, “human rights education”, and “economics-financial education”, respectively. When asked about the desirable school system after COVID-19, “maintain the current (grades 1-6)”, “operation of grade groups (grades 1-2, 3-4) Grade group, grades 5-6”, “Grades 1-5”, and “going to upper school through qualification tests without distinction of discipline” were chosen by 54.8% (n=255), 23.7% (n=110),

9.9% (n=46), and 9.7% (n=45) of the respondents, respectively. When asked which teacher class-oriented competencies will be most emphasized after COVID-19, “cooperation”, “safety”, “communication”, and “character” were selected by 17.8% (n=83), 16.3% (n=76), 14.2% (n=66), and 11.0% (n=51).

In Korea, after the Sewol ferry sank in 2014 and 250 students died, a ‘Safe Life’ topic was newly established in the first and second grades of elementary school to reinforce safety education. In addition, safety units were added to Science, Technology and Home Economics, and Physical Education from the 3rd grade of elementary school to the 3rd grade of high school. ‘Survival swimming’ education for the 3rd to 6th grades of the elementary school has also been expanded, and 5-minute safety education must be conducted in science experiments. After COVID-19, Safety Education was more emphasized in the school education system, and teachers recognize that this is achieved with integration between subjects. Curriculum integration focuses on learning with topics related to students' life and their safe and healthy lifestyles. Cross-curricular themes are required nationally and socially, to teach content that is not covered by the subject. Teachers need to practice various educational activities related to Safety Education, Health Education, and Character Education with autonomy in the cross-curricular themes of learning. Compared to the perceptions of pre-service teachers in Go et al.'s result (2020), both pre-service teachers and teachers emphasized integrated subjects and believe that the Science/Practice art subjects are at the center of integration. Teachers also emphasized autonomous and diverse activities through creative experiential activities, and pre-service teachers considered it important to transmit social values through Social studies/Moral Education. Pre-service teachers emphasized ‘Democratic Citizenship Education’ as an important topic after COVID-19, while teachers emphasized ‘Character Education’. After COVID-19, the most important keywords in education were ‘cooperation’ and ‘safety’ for both teachers and pre-service teachers, but teachers emphasized ‘the value of communication’ while pre-service teachers emphasized ‘value of consideration’.

4.5 Operation of Pre-Service Teacher in Education System after COVID-19

Changes in teachers' perceptions of the operation of the pre-service teacher education system after COVID-19 consisted of a total of 2 questions as shown in Table 11. In each question, teachers' perceptions regarding the educational content and teaching method to be emphasized in the future teacher training stage were answered.

Table 11. Direction of the pre-service teacher education system after COVID-19

Question	Options	Number (%)
What do you think should be emphasized in teacher training after COVID-19?	Expansion of Convergence class	243 (52.3%)
	Strengthening information literacy	123 (26.5%)
	Strengthening of humanistic competence	73 (15.7%)
	Expansion of liberal arts courses	16 (3.4%)
	Others	10 (2.1%)
What kind of class do you think is desirable for teacher training institutions after COVID-19?	A parallel between distance learning and face-to-face learning	230 (49.5%)
	Deeper Learning and Cross Over Learning	224 (48.2%)
	Capstone course operation with improved field applicability	158 (34.0%)
	Individual projects	66 (14.2%)
	Cooperative learning	60 (12.9%)
	Personalized teaching and learning	42 (9.0%)
	Distance learning	28 (6.0%)
	Face-to-face lectures	27 (5.8%)
Others	3 (0.6%)	

When asked what should be emphasized in teacher training after COVID-19, 52.3% (n=243) of the respondent answered “expansion of convergence class” needs to be emphasized. 26.5% (n=123), 3.4% (n=16), and 15.7% (n=73) replied that “strengthening information literacy”, “strengthening of humanistic competence”, and “expansion of liberal arts courses” need to be emphasized, respectively. For the question of the desirable classes for teacher training institutions after COVID-19, 49.5% (n=230) 48.2% (n=224), 34.0% (n=158), 14.2% (n=66), 12.9% (n=60), 9% (n=42), 6% (n=28), and 5.8% (n=27) selected “a parallel between distance learning and face-to-face learning”, “deeper learning and cross over learning”, “capstone course operation with improved

field applicability”, “individual projects”, “cooperative learning”, “personalized teaching and learning”, “distance learning”, and “face-to-face lectures” to be important, respectively.

In the 4th industrial revolution, information and communication technology developed rapidly and the technology necessary for online education was also developed, but the change in education has been slow. However, due to COVID-19, online education has become a necessity rather than an option, and people are quickly adapting to contactless education. In the post-COVID-19 era, such online education is expected to be maintained in terms of affordability and accessibility, so that many people can enjoy the benefits of education. Teachers recognized that online education is important in teacher education even after COVID-19 and that a blended teaching method that combines online education and face-to-face lectures is appropriate. In addition, when faced with a global crisis such as COVID-19, it was recognized that convergence education was necessary to break away from the framework of the past. In the past, teachers focused on delivering the knowledge and skills for students. However, to cope with a pandemic such as COVID-19, students need to cultivate information literacy so that they can find, judge, and utilize necessary information, and based on this, educational activities that can actively solve problems must be conducted.

Regarding changes in education after COVID-19, both teachers and pre-service teachers thought that the blended class method, which combines remote and face-to-face lectures, was appropriate, and that classes should be conducted using deep learning and crossover learning. After COVID-19, education needs to be conducted so that students can learn high-level skills such as critical thinking, problem-solving ability, and cooperation beyond the level of memorizing knowledge, and a blended teaching method that combines various learning methods is applied.

5. Development Direction of Technology Education in Future Education

5.1 Transition of Competency, from Problem-Solving to Conceptual Design

“What direction will technology education take in the future?” can be replaced by “what are the competencies that can be cultivated through technology education in future education?” as many researchers see competency development as a key agenda for future education. Therefore, the discussion of the direction of technology education in future education is needed for understanding what future-oriented competencies can be cultivated through technology education. So far, the most important competency of technology education worldwide has been problem-solving (Halfin 1973; Hill and Wicklein 1999; Wicklein and Rojewski 1999). The current Korean curriculum suggests “technological problem-solving ” as a competency to be cultivated through technology education. Is problem-solving the most important competency in technology education in the future? In the previous survey on perceptions of Korean teachers, 96.8% of teachers predicted that new competencies would be required in future education after COVID-19. Given the perception of Korean teachers, the new competency must be related to future technology and needs to be a conceptual one that is creative and conducive to creating new things. Accordingly, the researchers are paying attention to the new competencies required in a new era, especially in education combined with AI. A competency that has been newly emphasized in Korea is "Concept Design ". Concept design refers to the ability to present new concepts for work, organization, and certain phenomena and refers to the ability to restructure and create something that did not exist before. (Lee 2017). In other words, the conceptual design starts from a blank sheet and creates a completely new concept. Concept design is closely related to creative thinking because it focuses on creating something. The most important characteristic of AI, which has recently been attracting attention in all fields of society, is a conceptual design based on such creative thinking. The main characteristic of AI is to generate new rules, that is, concepts based on big data. The goal of future education is to create an "educational ecosystem that adapts to changes in science and technology". The advent of AI is creating a new scientific and technological agenda, and technology education is also important to create a new ecosystem that adapts to the agenda.

5.2 Technology Education Based on Metaverse

After non-face-to-face education was implemented in Korea, the biggest concern of the education authorities was how to lead practice-oriented classes such as technology education in the situation. In the survey of teachers' perceptions, it was predicted that “expansion of project classes linked to school and home” (42.6%) would be necessary. In this teaching method, the change to “zoom-based remote class activation” (49.5%) and “individualized class in a package such as a module learning (30.5%) was predicted. In technology education with many hands-on activities, it is not easy to expand project classes and package classes to module learning, especially if it is based on distance learning like zoom. As an alternative to solve this problem, researchers are paying attention to the metaverse.

In Korea, discussions to use the metaverse for education have been active. The metaverse is a compound of meta (meaning fictitious and abstract), and the universe (meaning the real world and a three-dimensional extended virtual world). It is a more advanced concept than virtual reality (VR) and is attracting attention as a future core industry in various fields such as medical care

and entertainment. Recently, in Korea, there is an active discussion about how to utilize the metaverse in educational aspects, especially in practice-oriented education. The first case in which the concept of the metaverse is applied in practice-oriented education in Korea is "Study and Practice using 3D image software and 3D printing technology of anatomical body structure", an elective course of the College of Medicine of the Seoul National University and virtual garden experience in the field of agricultural technology as shown in Fig. 3. By expanding the application of medical images to the virtual world, students develop their ability to creatively and proactively use medical images in the fields of treatment, research, and education where they are active in the future. In a metaverse, friends meet and communicate in a virtual classroom such as ZEPETO Classroom (a metaverse platform operated by a Korean search portal called "Naver") which is designed as a virtual space with a 3D map for conducting various practical activities. In addition, the number of practices using metaverse-based games such as Minecraft is increasing. The metaverse allows students to practice activities even in the real world such as social distancing caused by COVID-19. The application of new technologies such as the metaverse in future technology education needs to be done in the overall aspect of education including the goal, content, and method of education from the perception of Korean teachers on future education. The reason that special attention is paid to the metaverse is connecting the virtual world and the practice space.



Fig. 2. Augmented Reality Avata ZEPETO from Naver



Fig. 3. Garden education contents using VR technology
<https://youtu.be/DYgyzLbLOzY>

5.3 Ethics of Technology

Previous studies (Haug 2017; Huyke 2001; Kim et al. 2013; Go 2021) emphasized the ethical aspects of technology. Korean teachers are also emphasizing ethical aspects such as "collaborating with others" as the most important factor in educational change after COVID-19. In addition, the values such as "human dignity" and "cooperation" were considered the most important value for education in Korea after COVID-19. Dealing with the ethical aspects of technology in education is important in a civilized society, too. If technology education deals with the ethics of technology, what would be the specific content? Again, implications can be found in Korean teachers' perceptions of future education.

In Table 7, the ethical aspects of technology in education are shown as the clarification of the relationship of how technology affects "human dignity", the scope and limitations that technology must observe concerning "human dignity", and the definition of technology to contribute to securing human autonomy and diversity. Finally and importantly, the role of technology to preserve the ecological environment in an ethical aspect needs to be dealt with in technology education. Go (2021) argued that the ethical self-regulation of humans in using technology is essential because technology is value-neutral without an internal standard of self-regulation. If the technology used for human convenience and in abundance lacks responsibility, regulation, and ethics, the destruction caused by technology is irreversible and fatal not only to society but also to the entire human race and all life. Unfortunately, technology education around the world does not deal with the ethics of technology in-depth, so improvement in this area is essential. Therefore, technology education must not be concerned only with how to make technology work better but needs to increase the humanities in an understanding of how technology is used.

6. Conclusion

This study was carried out to analyze the perceptions of Korean teachers on the appearance of future education after COVID-19, predict the direction of educational innovation based on this, and set a new direction for technology education in future education. In Korean teachers' perceptions of future education after COVID-19, the main keywords related to educational goals were "adaptation to new technology" and "pursuit of social values". In this direction, the curriculum "individualized distance education" and "project learning" were emphasized. Regarding teacher competency, "technology literacy" and "learning affordance" are

important. For the school education system, “integrated subjects” and “safety education and health education” was emphasized. The education system for pre-service teachers can be summarized as “expansion of convergence class” and “cultivation of information literacy” which are the most important. The future of technology education after COVID-19, based on the results of the survey results of these Korean teachers, does not simply have to repeat the problem-solving process through the convergent thinking of existing knowledge. Rather, classes are offered to develop conceptual design competency so that new concepts can be presented and structured. In addition, as previous technology education has ignored the problems in modern society by treating technology as value-neutral, after COVID-19, social problems and the relevance of technology must be looked at, and ethically value-oriented educational activities need to be conducted. In a situation where social values such as safety, cooperation, and consideration are important due to COVID-19, technology education needs to be incorporated with social values in technology education through collaboration with the humanities and social sciences.

Lastly, due to COVID-19, classes on online platforms will evolve from one-directional planforms into the metaverse where avatars communicate in a virtual world. Students will live a life that is no different from the real world in the metaverse and will experience innovative changes in education. New experiences and educational activities will be enabled outside of the existing limited educational activities in the classroom. The practical activities of subjects such as practical art, music, art, and physical education, which were only possible in the space of the classroom, will be carried out in the metaverse, and the students will overcome spatial limitations and freely participate in educational activities.

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