Educational Technology International
2019, Vol. 20, No. 1, 109-135

Elementary Teachers' Perception on Student Competencies, Teacher Role, and Instruction in the Forthcoming Educational Environmental Change

Yujung KO	Insook HAN	Hoilym KWON	Won Sug SHIN*
Korea University Korea	Temple University USA	Korea University Korea	Incheon Nat'l University Korea

Rapid development of educational technology requires fundamental changes not only in the form of instruction and role of teachers in school education but also in the competency development of students. Specifically, the emergence of new technologies such as makerspace, virtual reality (VR), and robotics has made it more challenging for teachers and students in the 21st century. However, even with the argument for the changes, less has been discussed about how much in-service teachers are aware of and how they are preparing for such changes. Therefore, this study intends to explore what would be required to students and teachers, and for instructional changes with more technologies available through the lens of elementary school teachers. The study results suggest, similar to previous studies, in-service elementary teachers recognize that student competencies such as creativity, collaboration, communication, and problem-solving skills are important. They also perceived that teacher change in role and attitude, and for instructional method and classroom culture are crucial as catalysts of change. Unique and interesting finding from this study is about the importance of nurturing digital citizenship in technology-infused learning environment. The digital citizenship has been less highlighted in the past, but this study revealed it should be treated as a priority.

Keywords : Emerging technologies, Teacher perception, Student competencies, Teacher role, Instruction, Delphi

* College of Education, Incheon National University
wss2105@gmail.com

Introduction

The development in technology reaches every dimension in our lives and it now is referred to as revolution. Since Schwab (2015) introduced the theme in his essay noting that 'We stand on the brink of a technological revolution that will fundamentally alter the way we live, work and relate to one another', the discussion around the Fourth Industrial Revolution has been started. This new era requires many changes not only in the context of industry but also in education.

One of the notable changes in education is an increasing number of new technologies that can be used in classroom. For example, Horizon Report identified makerspace and robotics as educational technologies that will be adopted in one year or less, and analytics technologies and virtual reality (VR) as what will be adopted in two or three years in K-12 education (Freeman, Adams Becker, Cummins, Davis, & Hall Giesinger, 2017). Recent studies on makerspace (e.g., Hsu, Baldwin, & Ching, 2017), robotics (e.g., Akçayır & Akçayır, 2017; Taylor & Baek, 2018), and VR (e.g., Dede, Grotzer, Kamarainen, & Metcalf, 2017; Ucar, Ustunel, Civelek, & Umut, 2017) for teaching and learning reflect the interests in emerging technologies in the field of education. Accordingly, technology-rich educational environment has changed how students learn and teachers instruct (Shute, Leighton, Jang, & Chu, 2016). In robotics activities, students are to work in groups not only due to limited resources in the engineering lab; it is also because collaboration is encouraged as a way to help students develop skills in designing, programming, and project management (Taylor & Baek, 2018). What teachers do in classroom also changes. In a 3D-based immersive, virtual learning environment, teachers function as a guide and supporter of students' work while students are exploring the virtual ecosystem and collecting data through various activities. After the virtual exploration, teachers lead discussions so that students can share their experiences and learning in the virtual world (Metcalf, Kamarainen, Grotzer, & Dede, 2013).

Literature reported teacher changes in practices from traditional lecture-based

teaching to student-centered, interactive instruction with more technologies available for teaching and learning (e.g., Cho & Lim, 2017; Takacs, Swart, & Bus, 2015). Technology enables instructional activities that have not been possible in the past. Some examples include activities where learners construct new knowledge after searching and organizing information with the use of technology (Neumann & Kopcha, 2018) and where they experience museums located far away through VR (Stoddard, 2018).

Teachers as a facilitator rather than a lecturer have also been emphasized when designing technology-enabled, learner-centered learning environment (e.g., McKnight et al., 2016). McKnight et al. (2016) summarized the benefits of using technology in teaching and learning activities. In the study, technology provided efficiencies in delivering and restructuring their teaching practice, helped students with a wide range of learning needs personalize their learning, and made transformative learning possible. However, in many cases, as Ertmer and Ottenbreit-Leftwich (2010) mentioned, it is not easy for teachers to adopt new technologies and make instructional changes in classroom. Often times, it accompanies changes in pedagogical belief, appropriate knowledge, awareness of technologies' added value, and culture to support technology use in practice. Furthermore, technology can be applied to classroom properly when factors such as knowledge, self-efficacy, and pedagogical beliefs intersect (Ertmer & Ottenbreit-Leftwich, 2010).

The influence of new technologies is now inevitable. Rapid advancement of technology in society would bring more technologies in schools, asking for teachers to help students equip with new skills and competencies for future. Given that teachers are decision-makers for instruction and bring changes into the classroom (Han, Shin, & Ko, 2017), it would be worthwhile to explore how teachers think about education in the future. However, little research has been conducted yet on how teachers perceive what would be needed for students as future workforce, what teachers' role would be, and how they need to teach with emerging

technologies coming into education. The new technologies that will be introduced to classroom will not be limited to the aforementioned ones (i.e., robotics, AR, and VR); other types of media that are not yet known to us might be used in near future for instructional purposes. Whatever technology is brought into classroom, however, teacher perception on future education would not immensely be different. Thus, in this study, we intended to investigate teacher perception on what will be required for our students, teachers, and classroom instruction to prepare for future education.

Relevant Literature

Teacher role

New technologies create new possibilities in educational situations. In order to leverage the technologies in instructional practices, it is important that teachers have necessary skills and knowledge to use the technology in classroom. However, even with increasing trend of technology use for professional purposes among teachers, their use of classroom technology either remains at the surface level or is only to support traditional, teacher-directed instruction (Shin, 2015). This means that technology integration for teaching and learning is still in its infancy.

For technology integration, teachers' technology competency, which refers to teachers' basic technology skills, is important. Teacher skills and competencies for technology integration have been identified in previous studies. Examples were expertise, pedagogical know-how, understanding of technology, organizational competence and collaboration, flexibility, mobility and openness (OECD, 2005). In addition to skills, teacher knowledge for teaching in the 21st century has also been identified, which include: (a) knowledge of learners and how they learn and develop within social contexts, (b) understanding of curriculum content and goals, and (c)

understanding of and skills for teaching (Darling-Hammond, 2006).

However, having technology competency does not naturally lead teachers to use technology. Ertmer and Ottenbreit-Leftwich (2010) stressed that technology integration requires fundamental changes in the following four dimensions: (a) beliefs including attitudes and pedagogical ideologies; (b) subject related content knowledge; (c) pedagogical knowledge; and (d) educational context including instructional resources and administrative support. In other words, technology will be incorporated in a meaningful way when teachers adjust their belief, develop pedagogical knowledge and content knowledge according to new technologies, and moreover, are supported for technology use in classroom.

The property of technological devices support teachers' activities in classroom, especially when it aligns with teachers' pedagogical belief (Tondeur, van Braak, Ertmer, & Ottenbreit-Leftwich, 2017). Literature reported that teachers with constructivist belief have a tendency to utilize technology actively and employ various types of teaching strategies than teachers who have lecture-based teaching approach (Han, Shin, & Ko, 2017; Prestridge, 2012). In addition, teachers with constructive belief may use technology in a way to support the development of students' skills, such as communication, collaboration, critical thinking, and creativity to prepare them for 21st century (Ertmer, Ottenbreit-Leftwich, & Tondeur, 2015). Thus, it is important for teachers to change their pedagogical beliefs to make meaningful use of newer technologies. This change in pedagogical beliefs, in turn, can lead to changes in teaching and learning methods and changes in the educational environment.

Student competencies and changes for instructional practices

Technological advancement has brought many changes in our daily lives. Reflecting the changes in societal evolution and demands, educational institutions and organizations introduced skills and standards for future students. For example,

OECD identified 21st century skills and competencies required for students to be effective workers and citizens, including three broad categories of learning and innovation skills, information, media and technology skills, and life and career skills (OECD, 2013).

More specific to technology, International Society for Technology in Education (ISTE, 2016) announced ISTE standards for students, underscoring seven standards that students need to be prepared for. The seven standards include: empowered learner, digital citizen, knowledge constructor, innovative designer, computational thinker, creative communicator, and global collaborator. Also, the Partnership for 21st Century Learning (P21, 2015) produced conceptualization of skills for 21st century student, which is a more detailed and widely adopted theoretical framework. In the framework, it describes four learning and innovation skills (i.e., critical thinking, communication, collaboration, and creativity), emphasizing that students should be equipped with those skills for their future. Dede (2010) mentioned that such frameworks and skillsets from P21, OECD, and ISTE have suggested how school curriculum should be changed. When those skills are developed through education system, students will naturally be able to cultivate digital citizenship. The digital citizenship education closely aligns with the direction of general youth citizenship education, and can be focused on using the Internet resources to (a) have youth practice respectful and tolerant behaviors to others; and (b) increase their civic engagement (Jones & Mitchell, 2019). The digital citizenship education program would be beneficial to student to prepare for their future career as it generally includes the following topics: Internet safety, privacy and security, relationships and communication, cyberbullying, digital footprints, reputation, self-image and identity, information literacy, and creative credit and copyright (Common Sense Media, 2012).

The focus on constructivism coupled with technological development brought attention to learner-centered education (Jonassen & Land, 2012). The learner-centered model in teaching and learning emphasizes promoting student

competencies such as collaboration, problem-solving skills, and higher-order thinking (An & Reigeluth, 2011). The learner-oriented activities have been proved to be effective to foster students' skills such as creativity, problem-solving, and collaboration, and technologies can help develop the skills more effectively. For example, Hsu, Wenting, and Hughes (2018) used augmented reality (AR) to improve digital literacy of elementary students. They found that students showed improvement in collaboration, communication and sharing, and problem-solving skills (Hsu, Wenting, & Hughes, 2018). In another study, Taylor and Baek (2018) reported an increase in students' collaborative problem-solving skills, which was developed through collaborative robotics projects (Dede, 2010).

Change in teaching and learning methods is an essential component for educating future students. Understanding teachers' view on what skills students need to be equipped with and how teaching and learning should be changed accordingly would help us draw implications for future education. Thus, the current study was guided by the following research questions:

1. What are students' competencies newly required?
2. What is the role of teachers?
3. How should the instruction be transformed for the education with the emerging technologies?

Methods

Delphi method

This study used the Delphi method (Adler & Ziglio, 1996; Okoli & Pawlowski, 2004) to identify priorities for student competencies, teacher role, and the transformation of instruction necessary for the coming future. The Delphi method enables researchers to obtain consensual and consistent opinions from experts that

are in-depth and high quality (Lee, 2014). For expert panel to answer these questions, three rounds of collecting responses were implemented, which is a suggested way to obtain stability in responses in a Delphi study (Rowe & Wright, 2001).

Procedures and analysis

The experts were recruited with the following two criteria: at least five years of teaching experience in elementary schools, and a willingness to contribute. In Korea, after three years of teaching, teachers become eligible to get advanced teaching licensure, which can be regarded as an expert in the education field.

Initially, the research team selected 17 elementary teachers who are working at experimental or innovative schools and showed an interest to study participation. However, the study continued with 11 teachers, who completed the first round of survey, as the expert panel. It is still a valid number of participants as literature recommends having approximately 10 – 18 experts in a Delphi study (Okoli & Pawlowski, 2004). All of the teacher participants have used online learning, robotics, and AR/VR for instructional practices. The teachers were explained the purpose of the current study and asked to answer the survey. Finally, 10 out of 11 experts completed all three rounds of the Delphi study. The respondents (N = 10) reported to have an average of seven years of teaching in elementary schools ranging from 18 to 35 in capacity located in metropolitan areas of South Korea. Four (40 %) of the experts were female teachers and six (60 %) were males.

The first round was implemented through an online open-ended survey. An email invitation with a link to the survey was sent to teacher participants. In the survey, the teachers were first provided background information regarding the emerging technologies and the expected changes in education. Then the experts were asked to freely list the most important competencies required to students and teachers, and for instructional practices to prepare students for the future.

Their qualitative text responses were analyzed and categorized into emerging themes under the three areas of student competencies, teacher role, and transformation of instructional practices. Four Ph.D.s in educational technology first individually reviewed all qualitative data and extracted keywords. Going through internal discussions, the keywords were grouped into similar themes, which then a survey for the second round of Delphi was based upon. For each theme, the four coders tried to reflect the original meanings from teacher responses as much as possible, using the keywords provided in the responses, and decided final themes when the coders all agreed. In case of discrepancies among the coders, discussions continued until the four reached an agreement.

In order to identify priorities of the themes in the three areas, the second round with an online questionnaire asked experts to rate the themes emerged from the first round on a scale of importance ranging from 1 (Not important at all) to 5 (Very important). Finally, in the third round, the teacher experts were asked to rate again the importance of each theme, comparing their previous responses as well as other experts' responses. A 5-point Likert scale with 1 being *Not important at all* and 5 being *Very important* was used for the third round survey.

With the survey responses collected, mean, and standard deviation (SD), median, and quartiles of each theme response were computed to verify the results of Round 2 and 3. Themes with over 0.62 in Content Validity Ratio (CVR) were retained in the survey as they are considered to have content validity when there are 10 of expert panel (Lawshe, 1975). Convergence and consensus were computed to validate the use of Delphi method. When opinions from an expert panel are all merged, the value of convergence is 0. The convergence value increases if the opinions are divergent. For consensus, if all experts fully agree each other, its value would be 1. The value of stability was used to ensure no more round is needed. Stability score below 0.5 indicates less discrepancy among experts' responses in survey, and thus, additional round of survey is not necessary.

Table 1. Delphi study process

Process		Information
Step 1	Experts panel selection	Researchers selected in-service elementary school teachers for the Delphi study
Step 2	Survey round 1	The teachers were asked to identify and solicit ideas for education with the emerging technologies in regard to: 1. Newly required of students' competencies; 2. The role of teachers; and 3. Instructional change
Step 3	Survey round 2	The researchers analyzed the text responses and categorized them into different themes. The teachers were asked to rate the themes.
Step 4	Survey round 3	The teachers were asked to re-rate the themes.

Results

Round 1

The Delphi panel generated a total of 61 statements in Round 1. Among them, 26 statements were about student competencies while 18 statements for teacher role and changes in instructional practices, respectively. The statements then were grouped into themes, which resulted in seven student competencies of the newly required, eight teacher roles to be emphasized, and six directions of instruction to be transformed with the new technologies in society (see Table 2, 3, & 4). In student competencies, for example, *the ability to create new ideas* from participant C and *students with the ability to interpret problems from various perspectives* from participant I were categorized into *creative minds*, which then was named as *creativity*. The emerged themes in the three categories were used in questionnaire for Round 2.

Table 2. Round 1 Delphi result for student competencies

Theme	Frequency	Response
Problem-solving skills	5	• An attitude to try out challenging problems (participant D) • Critical thinking skills for synthesizing, analyzing, and evaluating information (participant H) • Identifying problems and making decisions (participant J) • Problem-solving skills (participant E & H)
Collaboration	5	• The ability to value diversity and work together with others (participant A) • The ability to communicate and collaborate with others (participant E) • The ability to reconstruct ideas through discussion (participant D) • The ability to communicate and interact with others (participant H) • The ability to collaborate between humans, human and machine (participant H)
Creativity	5	• The ability to create new ideas (participant C) • The ability to develop creative ideas (participant C) • Students with creative thinking skills (participant G) • Students with the ability to interpret problems from various perspectives (participant I) • Student with a creative power (participant J)
Digital citizenship	5	• An attitude to respect for the rights of others (participant A) • The ability to make judgments on ethical behavior when using technology (participant B) • Well-rounded individuals in the digital age (participant G) • The ability to manage their identity and take control of their behaviors (participant G) • The ability to participate in civic life in a rapidly-changing world (participant J)
Communication	4	• The ability to communicate and sympathize with others (participant D) • Listen carefully to others and express themselves clearly (participant G) • The ability to make reasonable decisions through communication with others (participant H) • The ability to be responsive to diverse perspectives (participant J)
Self-directed learning skills	2	• The ability to set their learning goals and take the initiative in their learning (participant G) • The ability to reflect on the learning process and achieve learning goals (participant I)
Information processing skills	3	• The ability to process and utilize information (participant B & C) • The ability to locate and use new information (participant E)

Table 3. Round 1 Delphi result for teacher role

Theme	Frequency	Response
Facilitator	1	• Teacher as a guide and facilitator for student learning (participant E)
Digital Citizenship education	6	• Guiding students for legal and ethical behaviors in technology-rich environment (participant B) • Inspiring students to make a contribution to the digital age in diverse ways (participant G) • Helping students cultivate an attitude to embrace diversity and respect (participant I) • Mentoring students in different stages of identity development off- and on-line (participant I) • Guiding students on socially responsible behaviors in a digital world (participant I) • Being able to understand students' online behaviors (participant I)
Designing and integrating new teaching approach	6	• Designing and providing problems that promote students' collaboration and communication (participant E) • The ability to create learning materials using various digital tools (participant H) • The ability to design creative learning activities that meet learning goals and to implement them (participant H) • Promoting discussion-based, problem-based, and question-and-answer-based learning activities (participant I) • Creating learning environment that encourage students' independent learning (participant I) • Providing students questions continuously to foster their ability to interpret problems from different perspectives (participant J)
Nurturing creative students	1	• Nurturing students who have rich ideas and attitude to challenge issues (participant F)
Advancing classroom culture	3	• Building a classroom culture where students feel free to develop knowledge on their own and speak out new ideas (participant C) • Establishing a democratic culture that protects self-expression and respect others' opinions (participant C) • Fostering students' ability to express themselves clearly (participant I)
Flexible attitude	2	• The ability to respond and re-shape teaching and learning as society and technology changes (participant F) • The ability to keep up with new knowledge and accommodate changes (participant H)
Re-organizing curriculum	2	• Developing theme-based, interdisciplinary, project-based curriculum (participant D) • Considering curriculum and evaluation together to promote formative assessments and student development (participant G)
ICT competency	2	• The ability to leverage technology to create authentic learning activities (participant D) • Being able to use technology to support student learning experiences (participant H)

Table 4. Round 1 Delphi result for transformation of instruction

Theme	Frequency	Code
Problem-based learning approach	3	• Solving problems through communication and collaboration with peers (participant A) • Creating innovative artifacts after analyzing information provided (participant C) • Teaching and learning activities focused on identifying and solving problems (participant I)
Self-directed learning approach	4	• Motivating students with learning activities relevant to their lives (participant A) • Providing students opportunities to reflect their learning (participant B) • Creating learner-centered environment for students to manage their learning (participant H) • Helping students take the initiatives in their learning (participant J)
Discussion -oriented approach	3	• Discussion-based instruction that enables students to coordinate opinions and produce better outcomes (participant C) • Creating learning environment where students can develop communication and interpersonal skills through discussions (participant G) • Developing students' ability to examine problems from different viewpoints by listening others' opinion (participant J)
Authentic learning approach	7	• Implementing project-based instruction with authentic, real-world problems (participant D) • Applying appropriate instructional models and strategies to achieve learning goals (participant E) • Modifying existing instructions and devising new approaches for interactive teaching and learning (participant F) • Implementing context-based instruction that develops student creativity and collaboration (participant H) • Designing integrated, interdisciplinary instructions (e.g., STEAM lessons) (participant H) • Developing instructional models to foster student creativity (participant I) • Using instructional approaches that stimulate different areas in brain (participant I)
ICT-based learning approach	4	• Cultivating students' digital literacy (participant B) • Incorporating new technologies whenever appropriate (participant F) • Utilizing emerging technologies for effective instruction (e.g., Artificial Intelligence (AI), Internet of Things (IoT), 3D printing) (participant G) • Teaching programming (participant J)
Adaptive learning approach	2	• Customizing curriculum and learning contents tailored to student competencies (participant H) • Providing individualized learning tasks (participant H)

Round 2

Round 2 was conducted to validate the seven student competencies, eight teacher roles, and six instructional practices that were listed by expert panel in Round 1. Table 5 shows mean, SD, median, CVR, convergence, and stability values by each theme. All themes had mean of above 4.0, which can be considered to be high. However, five themes were excluded for Round 3 questionnaire because the value of CVR was below 0.62, implying invalid content. The removed themes were: information processing skills (CVR = 0.60) in student competencies, ICT competency in teacher role (CVR = 0.60), authentic learning approach (CVR = 0.60), ICT-based learning approach (CVR = 0.40), and adaptive learning approach (CVR = 0.20) in instructional practices.

Most highly scored skill for students was problem-solving with mean score of 4.90 (*SD* = 0.32), followed by collaboration (*M* = 4.80, *SD* = 0.42) and creativity (*M* = 4.80, *SD* = 0.42). In contrast, self-directed learning skills scored lowest with its mean of 4.60 (*SD* = 0.70). For teacher role, teachers reported that their role as facilitator would be of the most importance for future (*M* = 4.80, *SD* = 0.42) while re-organizing curriculum would be of the least importance (*M* = 4.30, *SD* = 0.67). With regard to instructional changes, problem-based learning approach was thought to be the most required for future (*M* = 4.80, *SD* = 0.42) by teacher participants.

Round 3

Round 3 was performed to test the validity of the themes from Round 2. In general, Round 3 result show that teachers thought creativity and problem-solving skills for student competencies, supporting digital citizenship education for teacher role, and self-directed learning approach would be the most important ones for future education. All themes were reported to have high in mean with its score over 4.5 (see Table 6).

Table 5. Round 2 Delphi result

Area	Theme	Mean	SD	Mdn	CVR	Con.	Sta.
Student competencies	Problem-solving skills	4.90	0.32	5.00	1.00	0.00	0.06
	Collaboration	4.80	0.42	5.00	1.00	0.00	0.09
	Creativity	4.80	0.42	5.00	1.00	0.00	0.09
	Digital citizenship	4.70	0.67	5.00	0.80	0.00	0.14
	Communication	4.60	0.70	5.00	0.80	0.38	0.15
	Self-directed learning skills	4.60	0.70	5.00	0.80	0.38	0.15
	Information Processing skills*	4.40	0.84	5.00	0.60	0.50	0.19
Teacher role	Facilitator	4.80	0.42	5.00	1.00	0.00	0.09
	Digital citizenship education	4.70	0.67	5.00	0.80	0.00	0.14
	Designing and integrating new teaching approach	4.70	0.48	5.00	1.00	0.38	0.10
	Nurturing creative students	4.70	0.67	5.00	0.80	0.00	0.14
	Advancing classroom culture	4.60	0.52	5.00	1.00	0.50	0.11
	Flexible attitude	4.50	0.53	4.50	1.00	0.50	0.12
	Re-organizing curriculum	4.30	0.67	4.00	0.80	0.50	0.16
	ICT Competency*	4.20	0.79	4.00	0.60	0.50	0.19
Transformation of instruction	Problem-based learning approach	4.80	0.42	5.00	1.00	0.00	0.09
	Self-directed learning approach	4.60	0.52	5.00	1.00	0.50	0.11
	Discussion-oriented approach	4.50	0.71	5.00	0.80	0.50	0.16
	Authentic learning approach*	4.30	0.82	4.50	0.60	0.50	0.19
	ICT-based learning approach*	4.20	0.92	4.50	0.40	0.88	0.22
	Adaptive learning approach*	4.00	0.94	4.00	0.20	1.00	0.24

*_Note_. Rejected (CVR < .62)

Table 6. Round 3 Delphi result

Area	Theme	Mean	SD	Mdn	CVR	Con.	Sta.
Student competencies	Creativity	4.90	0.32	5.00	1.00	1.00	0.06
	Problem-solving skills	4.90	0.32	5.00	1.00	1.00	0.06
	Collaboration	4.80	0.42	5.00	1.00	1.00	0.09
	Digital citizenship	4.80	0.42	5.00	1.00	1.00	0.09
	Self-directed learning skills	4.80	0.42	5.00	1.00	1.00	0.09
	Communication	4.60	0.70	5.00	0.80	0.85	0.15
Teacher role	Digital citizenship education	4.90	0.32	5.00	1.00	1.00	0.06
	Designing and integrating new teaching approach	4.80	0.42	5.00	1.00	1.00	0.09
	Facilitator	4.80	0.42	5.00	1.00	1.00	0.09
	Nurturing creative students	4.80	0.42	5.00	1.00	1.00	0.09
	Advancing classroom culture	4.60	0.52	5.00	1.00	0.80	0.11
	Re-organizing curriculum	4.60	0.52	5.00	1.00	0.80	0.11
	Flexible attitude	4.50	0.53	4.50	1.00	0.78	0.12
Transformation of instruction	Self-directed learning approach	4.90	0.32	5.00	1.00	1.00	0.06
	Problem-based learning approach	4.80	0.42	5.00	1.00	1.00	0.09
	Discussion-oriented approach	4.50	0.71	5.00	0.8	0.80	0.16

In terms of student competencies, even though rankings among themes were shuffled a bit from Round 2, all the themes scored 1 in CVR except communication (CVR = 0.8), which means they all remain in the survey. For changes in teacher role, content validity was high (CVR = 1) in all eight themes of: re-organizing curriculum, facilitator, designing and integrating new teaching approach, digital citizenship education, advancing classroom culture, nurturing creative students, and flexible attitude. As in student competencies, rankings among the eight themes under teacher role have slightly been changed with digital citizenship education being the most important one in Round 3. Themes under transformation of instruction have also been re-ranked from the results of Round 2, but all three themes remained in the survey with high CVR over 0.8.

The validity of Delphi method was also tested in Round 3 with the value of convergence and stability. It was found that convergence is above .70 and stability is below .05 for all items. The results mean the expert panel reached consensus on the questionnaire items used in Round 3 and no more round in the Delphi study is needed.

Discussion and Conclusions

This study explored what would be required to students and teachers, and for instructional changes with more technologies available through the lens of elementary school teachers. From the results of the research, we were able to confirm the role of the teacher and how the class should be changed, along with the students' competencies in various areas that have already appeared in previous studies. For students, most of the competencies teachers placed value on overlaps with ISTE standards for students (ISTE, 2016). Specifically, creativity, collaboration, and communication were already mentioned by the Partnership for 21st Century Learning (2015) as skills that students would need to possess in the future. Other

student competencies such as problem-solving skills have been underscored by researchers for its importance (e.g., Tondeur et al., 2017) and numerous studies were conducted to promote students' problem-solving skills (e.g., Häkkinen et al., 2017). In addition, the results from student competencies are in line with the one from transformation of instructional practices, which teachers perceived problem-based learning approach and discussion-oriented approach would be required for future education. Previous studies have demonstrated that the problem-based and discussion-oriented approach for instruction helped promote students' skills such as creativity (van Laar, van Deursen, van Dijk, & de Haan, 2017), problem-solving (Häkkinen et al., 2017), and collaboration (Häkkinen et al., 2017).

Interestingly, this study revealed that teachers' thought about being able to design and integrate new teaching approach to incorporate the emerging technologies. They also thought having flexible attitude towards changes and advancing classroom culture would be crucial. With the flexibility, teachers accommodate changes. They are not "knowledge transmitter" any more; rather, they work *with* students as co-learner, solving problems and probing issues together. The openness and flexibility among teachers also mirror their willingness to use new technologies and make changes in instruction accordingly. This positive attitude to changes plays a pivotal role in shaping innovative teaching and learning activities (Yildirim & Kasapoglu, 2015). In addition, from the study, teacher perception on advancing classroom culture can be interpreted that the current classroom culture would need to be transformed into the one where students can freely voice their opinions out and participate equally in classroom activities. Classroom cultures where students actively take part in learning allow teachers to be a more productive user of technology with constructivist-based instructional practices (Ertmer & Ottenbreit-leftwich, 2010).

The influx of technology in school and the focus on learner-centered approach have made teachers change their instructional practices (Ertmer, Ottenbreit-

Leftwich, Sadik, Sendurur, & Sendurur, 2012; Tondeur et al., 2017). The current study confirmed that emerging technologies would keep requiring teachers for changes. Previously, numerous studies reported teachers' unchanging ways of instruction even with new technological affordances available to them (Shin, 2015; So, Choi, Lim, & Xiong, 2012). They were stick to the ways they used to teach in old days and resisted to accommodate the changes (Baek, Jong, & Kim, 2008; Shin 2015). In contrast, however, this study results show teachers perceive those changes are inevitable and it is natural to adjust classroom culture and their role accordingly. This can be understood that teachers' attitudes towards technology in classroom are becoming more positive. Literature has been emphasizing the importance of providing professional development (PD) for in-service teachers to promote the positive changes among teachers. Sustained PD opportunities allow teachers to learn ways to incorporate new technologies in teaching and learning as well as serve as chances to develop their ability (Shin, 2015; Yildirim & Kasapoglu, 2015).

Unique and interesting finding from this study is about digital citizenship in technology-infused learning environment. Teacher participants in the study asserted students would need to develop digital citizenship and teachers would be able to support them through digital citizenship education. This finding may indicate that digital citizenship education is the most needed and important area in our education given that more and more technologies will be introduced to students in the future weather we like it or not. Nonetheless, the digital citizenship has been less highlighted in the past when discussing students' future competencies. It has often been considered as supplementary or secondary to education while other skills and competencies were given priorities for future education. However, as more technologies are being used in everyday life, how to use them properly and meaningfully gets attention. It is not hard to hear student misbehaviors and misconduct online such as cyberbullying through SNS (Lee & Shin, 2017), which are side effects of pervasive technology use.

The ethical behavior in a digital world is partially in line with one of the ISTE

standards for students (2015), which emphasize the theme of digital citizen, but the scope of digital citizenship mentioned by teachers in the current study is not limited to the digital world. The teachers mentioned students should be able to respect others, embrace diversity and inclusion, and make right decisions as well-rounded individuals both off- and on-line, and teachers should make their efforts to help students develop those characteristics. Their thought extends to where school is responsible for general youth citizenship education as we are living and will live in a world surrounded by numerous technologies. In this regard, teaching basic technical skills or giving a new, fancy technology toy in students' hands would be of less importance to digital natives; what is more important for future students would be to cultivate how to make use of technology in educational, ethical, and productive ways through a long period of time. More research on digital citizenship in connection with technology-integrated education would guide the direction for future education.

The current study also has several limitations in that it might not be applicable to other context. The study was conducted with elementary school teachers in Korea. The teacher participants were from experimental or innovative schools with experiences of using new technologies in their classroom, which might not represent opinions from teachers in general public schools. Furthermore, the teachers in the current study have less than 10 years of teaching experience. During expert panel selection, the researchers looked for teachers who have used emerging technologies in classroom, which resulted in not having experienced teachers with more than 10 years of teaching. Similar studies in other public schools or with different teacher population (e.g., more experienced teachers) might yield different results. The fact that this was a Delphi study with a limited number of participants might also influence the study results performed through other research methods.

In addition, we focused primarily on expected changes for teachers and students as more emerging technologies are introduced to the field of education. Again, the goal of the current study is to explore overall teacher perception on new

educational technologies coming into classroom rather than focusing on the use of certain technologies such as robotics, AR/VR. Thus, our findings might be different from the studies that investigated teacher perception on the use of current technologies available in classroom. Lastly, as there are many different ways to adopt and use emerging technologies in education, other theoretical framework such as Diffusion of Innovation might produce different approaches and results.

References

Adler, M. & Ziglio. E. (1996). *Gazing into the oracle: The Delphi method and its application to social policy and public health*. London, UK: Jessica Kingsley.

An, Y.-J., & Reigeluth, C. (2011). Creating technology-enhanced, learner-centered classrooms. *Journal of Digital Learning in Teacher Education*, *28*(2), 54–62. doi:10.1080/21532974.2011.10784681

Akçayır, M., & Akçayır, G. (2017). Advantages and challenges associated with augmented reality for education: A systematic review of the literature. *Educational Research Review 20*, 1-11.

Baek, Y. G., Jong, J., & Kim, B. (2008). What makes teachers use technology in the classroom? Exploring the factors affecting facilitation of technology with a Korean sample. *Computers* & *Education, 50*, 224-234.

Common Sense Media (2012) K-12 digital literacy and citizenship curriculum: scope and sequence tool. Available at: http://www.commonsensemedia.org/educators/scope-and-sequence

Cho, Y. H., & Lim, K. Y. T. (2017). Effectiveness of collaborative learning with 3D virtual worlds. *British Journal of Educational Technology, 48*(1), 202-211.

Darling-Hammond, L. (2006). Constructing 21st-century teacher education. *Journal of Teacher Education, 57*(3), 300-314.

Dede, C. (2010). Comparing frameworks for 21st century skills. In J. Bellanca & R. Brandt (Eds.), *21st century skills: Rethinking how students learn* (pp. 51-76). Bloomington, IN: Solution Tree Press.

Dede, C., Grotzer, T. A., Kamarainen, A., & Metcalf, S. (2017). EcoXPT: Designing for deeper learning through experimentation in an immersive virtual ecosystem. *Journal of Educational Technology* & *Society, 20*(4), 166-178.

Ertmer, P. A., & Ottenbreit-Leftwich, A. T. (2010). Teacher technology change: How knowledge, confidence, beliefs, and culture intersect. *Journal of research on Technology in Education*, *42*(3), 255-284.

Ertmer, P. A., Ottenbreit-Leftwich, A. T., Sadik, O., Sendurur, E., & Sendurur, P. (2012). Teacher beliefs and technology integration practices: A critical relationship. *Computers & Education*, *59*(2), 423-435. doi:10.1016/j.compedu.2012.02.001

Ertmer, P. A., Ottenbreit-Leftwich, A., & Tondeur, J. (2015). Teacher beliefs and uses of technology to support 21st century teaching and learning. In H. R. Fives & M. Gill (Eds.), *International handbook of research on teacher beliefs* (pp. 403-418). New York: Routledge.

Freeman, A., Adams Becker, S., Cummins, M., Davis, A., & Hall Giesinger, C. (2017). *Horizon report: 2017 K–12 edition*. Austin, TX: The New Media Consortium.

Häkkinen, P., Järvelä, S., Mäkitalo-Siegl, K., Ahonen, A., Näykki, P., & Valtonen, T. (2017). Preparing teacher-students for twenty-first-century learning practices (PREP 21): A framework for enhancing collaborative problem-solving and strategic learning skills. *Teachers and Teaching, 23*(1), 25-41.

Han, I., Shin, W. S., & Ko, Y. (2017). The effect of student teaching experience and teacher beliefs on pre-service teachers' self-efficacy and intention to use technology in teaching. *Teachers and Teaching, 23*(7), 829-842.

Hsu, Y. C., Baldwin, S., & Ching, Y. H. (2017). Learning through making and maker education. *TechTrends, 61*(6), 589-594.

Hsu, H-P, Wenting, Z., & Hughes, J. E. (2018). Developing elementary students' digital literacy through augmented reality creation: Insights from a longitudinal analysis of questionnaires, interviews, and projects. *Journal of Educational Computing Research*. Advance online publication

Hur, J. W., Shannon, D., & Wolf, S. (2016). An investigation of relationships between internal and external factors affecting technology integration in classrooms. *Journal of Digital Learning in Teacher Education*, *32*(3), 105–114. doi:10.1080/21532974.2016.1169959

International Society for Technology in Education. (2016). ISTE standards for students.

Retrieved from http://www.iste.org/standards/standards/for-students-2016

Jones, L. M., & Mitchell, K. J. (2016). Defining and measuring youth digital citizenship. *New Media & Society*, *18*(9), 2063-2079.

Jonassen, D. H., & Land, S. (2012). *Theoretical foundations of learning environments* (2nd ed.). New York: Routledge.

Lawshe, C. H. (1975). A quantitative approach to content validity. *Personnel Psychology, 28*, 563–575.

Lee, C., & Shin, N. (2017). Prevalence of cyberbullying and predictors of cyberbullying perpetration among Korean adolescents. *Computers in Human Behavior, 68*, 352-358.

Lee, C-S. (2014). Delphi survey for improvement of the textbook selection system. *Journal of Research in Curriculum & Instruction, 18*(3), 561-578.

McKnight, K., O'Malley, K., Ruzic, R., Horsley, M. K., Franey, J. J., & Bassett, K. (2016). Teaching in a digital age: How educators use technology to improve student learning. *Journal of Research on Technology in Education, 48*(3), 194-211.

Metcalf, S. J., Kamarainen, A. M., Grotzer, T., & Dede, C. (2013). Teacher perceptions of the practicality and effectiveness of immersive ecological simulations as classroom curricula. *International Journal of Virtual and Personal Learning Environments*, *4*(3), 66–77. https://doi.org/10.4018/jvple.2013070105

Neumann, K. L., & Kopcha, T. J. (2018). The use of schema theory in learning, design, and technology. *TechTrends*, *62*(5), 429-431.

OECD. (2005). *Formative assessment: Improving learning in secondary classrooms*. Paris: OECD Publishing.

OECD (2013). *Teachers for the 21st century: Using evaluation to improve teaching*. Paris: OECD Publishing

Okoli, C., & Pawlowski, S. D. (2004). The Delphi method as a research tool: An example, design considerations and applications. *Information & Management, 42*(1), 15-29.

Partnership for 21st Century Learning. (2015). Framework for 21st century learning.

Retrieved from http://www.battelleforkids.org/networks/p21/frameworks-resources

Rothwell, W. J. & Lindholm, J. E. (1999). Competency identification, modelling and assessment in the USA. *International Journal of Training and Development, 3*(2), 90-105.

Rowe, G., & Wright, G. (2001). Expert opinions in forecasting: The role of the Delphi technique. In J. Scott Armstrong (Ed.), *Principles of forecasting* (pp. 125-144). Boston, MA: Springer.

Prestridge, S. (2012). The beliefs behind the teacher that influences their ICT practices. *Computers* & *Education, 58*(1), 449-458.

Shin, W. S. (2015). Teachers' use of technology and its influencing factors in Korean elementary schools. *Technology, Pedagogy and Education, 24*(4), 461-476.

Shute, V. J., Leighton, J. P., Jang, E. E., & Chu, M.-W. (2016). Advances in the science of assessment. *Educational Assessment*, *21*(1), 34–59. doi:10.1080/10627197.2015.1127752

Schwab, K. (2017). *The fourth industrial revolution*. New York: Currency.

Schwab, K. (2015, December). The fourth industrial revolution: What it means and how to respond. *Foreign Affairs*. Retrieved from https://www.foreignaffairs.com/articles/2015-12-12/fourth-industrial-revolution

So, H. J., Choi, H., Lim, W. Y., & Xiong, Y. (2012). Little experience with ICT: Are they really the Net Generation student-teachers? *Computers* & *Education, 59*(4), 1234-1245.

Stoddard, J. D. (2018). Learning history beyond school: Museums, public sites, and informal education. In S.Metzger & L. M. Harris (Eds.), *The Wiley international handbook of history teaching and learning* (pp. 631-656). Medford, MA: Wiley-Blackwell.

Takacs, Z. K., Swart, E. K., & Bus, A. G. (2015). Benefits and pitfalls of multimedia and interactive features in technology-enhanced storybooks: A meta-analysis. *Review of Educational Research*, *85*(4), 698-739.

Taylor, K., & Baek, Y. (2018). Collaborative robotics, more than just working in groups. *Journal of Educational Computing Research*, *56*(7), 979–1004. doi:10.1177/0735633117731382

Tondeur, J., van Braak, J., Ertmer, P. A., & Ottenbreit-Leftwich, A. (2017). Understanding the relationship between teachers' pedagogical beliefs and technology use in education: A systematic review of qualitative evidence. *Educational Technology Research and Development*, *65*(3), 555-575.

Ucar, E., Ustunel, H., Civelek, T., & Umut, I. (2017). Effects of using a force feedback haptic augmented simulation on the attitudes of the gifted students towards studying chemical bonds in virtual reality environment. *Journal of Educational Technology Systems, 44*(4), 430-449.

van Laar, E., van Deursen, A. J., van Dijk, J. A., & de Haan, J. (2017). The relation between 21st-century skills and digital skills: A systematic literature review. *Computers in Human Behavior, 72*, 577-588.

Yildirim, A., & Kasapoglu, K. (2015). Teachers' perceptions of constructivist curriculum change as a predictor of their perceptions of the implementation of constructivist teaching–learning activities. *Asia Pacific Education Review*, *16*(4), 565-577.

Yujung KO

Research Professor, Dept. of Education, Korea University.

Interests: Technology integration, Use of emerging technologies, Teacher education

E-mail: yujung96@gmail.com

Insook HAN

Assistant Professor, Dept. of Teaching and Learning, Temple University.

Interests: Embodied cognition, Use of emerging technologies, Pre-service education for technology integration

E-mail: hanis79@gmail.com

Hoilym KWON

Ph.D. student, Dept. of Education, Korea University.

Interests: Instructional design, Teaching method

E-mail: kwonhl3@hanmail.net

Won Sug SHIN

Assistant Professor, College of Education, Incheon National University

Interests: Technology integration in school settings, Teacher education, Emerging technologies

E-mail: wss2105@gmail.com

Received: February 28, 2019 / Peer review completed: April 26, 2019 / Accepted: April 27, 2019