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Patterns of kindergarten children's social interaction with peers in the computer area

Eun Mee Lim

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Abstract This study explored how young children interact with their peers in the computer area of a public kindergarten classroom. Children's social interaction, as defined in this study, is the action of giving and taking information that results in children's knowledge construction and cognitive development that can be accomplished through peer-to-peer interactions. This kind of social interaction is referred to as "Cognitively Effective Social Interaction (CESI)" in this paper. Patterns of young children's social interaction with peers in the computer area of this classroom were discussed. Two teachers and 28 children in a full-day kindergarten classroom were observed and interviewed. The patterns of young children's social interaction that occurred in the computer area were described as parallel play, verbal conflicts, sociable interaction, knowledge construction through positive and negative processes, and non-verbal communication.

Keywords Social interaction · Early childhood education · Collaborative learning · Technology integration · Computer · Peer interaction

Introduction

Computer literacy and skills are increasingly important in the information era (Colker 2011; Grey 2011; McCarrick and Li 2007). Students' capabilities for managing technology are becoming more necessary. Moreover, more than one computer is located in early childhood education classrooms nowadays. Therefore, there has been more controversy on young children's technology use in early childhood education settings. The debate over these past two decades has focused largely on the impact of technology use on young children's learning. Some researchers stress that educational technology's impact on young children's learning should be studied across the four major developmental domains, including physical, cognitive, emotional, and social development (Clements and Sarama 2007; Vernadakis et al.

E. M. Lim (✉)
Department of Early Childhood Education, Ewha Womans University, 52, Ewhayeodae-gil, Seodaemun-gu, Seoul, Korea
e-mail: emlim81@ymail.com

2005). In particular, young children's social and emotional development as influenced by computer technology has received the most attention. Most concerns are that computer technology might isolate young children and impede social development (Armstrong and Casement 2000; Cords and Miller 2000). In contrast, many other researchers have found that young children are more likely to interact in the computer area (Maynard 2010; Zevenbergen 2007). Accordingly, the present study focused on young children's social interaction that took place in the computer area of an early childhood education classroom, and tried to explore the patterns of children's social interaction.

Of the findings that support computer use with young children, not only are children found to be more sociable, but they are also found to be more cooperative while using computers (Hyun and Davis 2005; Gimbert and Cristol 2004). Specifically, children spent nine times as much time talking to peers while on the computer as when doing puzzles (Haugland 2005). Furthermore, additional research has concluded that children with disabilities and shy children who have not been successful in other activity areas benefit in terms of social development from using computer technology (Clements and Sarama 2003; Hutinger and Johanson 2000). However, there have been few research studies investigating how computer technology is or should be integrated into early childhood curriculum (Colker 2011; Lin 2012; Maynard 2010). Among the studies that have been done, most have been survey studies that provide an overall picture of the current status of computer technology in early childhood education (Cullen and Greene 2011; Specht et al. 2002). Very few studies have focused exclusively on kindergartners' use of computers and technology (Nir-Gal and Klein 2004; Stephen and Plowman 2008; Wang et al. 2010). Because available research has missed the very important point that computers should be used in developmentally appropriate ways and specifically, in an integrative fashion, the present study will contribute to the literature by examining the interaction patterns of young children's knowledge construction in collaborative learning that was conducted in technologically integrated manners in early childhood education, meaning that young children's activities with computer technology are connected with other activities that take place in other interest areas. So the computer is not located in a separate computer lab.

In this study, the researcher explored how young children interact with their peers in a public kindergarten classroom. Patterns of young children's social interaction with peers in the computer area in this classroom were examined. Children's social interaction, as defined in this study, is the action of giving and taking information that results in children's knowledge construction and cognitive development that can be accomplished through peer-to-peer interactions. This kind of social interaction is referred as "Cognitively Effective Social Interaction (CESI)" in this paper. This social interaction is not merely the exchanging of information or just sharing emotions. It should be more than simple responses. CESI that leads to learning results from children helping one another and solving problems together through collaborative learning activities (Clements and Sarama 2003; Wohlwend 2010). The learning that is gained by CESI includes learning about on-going classroom topics, the way of using the computer, and the resources children can use through computer programs.

There have been many research studies on the effects of computer use in early childhood education compared with other activities in this setting (Colker 2011; Maynard 2010). However, the study about what young children are doing at the computer area in early childhood education classrooms and how these activities in this setting relate to knowledge gains has not been sufficient for explaining all of the educational issues raised by teachers and researchers who are eager to support and scaffold young children's knowledge construction through computer-supported collaborative learning. Therefore, this study has focused on observing how young children interact with their peers in the computer area and how this social interaction with peers results in young children's educationally meaningful knowledge construction through different kinds of social interactions. The research question is as follows: What are the patterns of kindergarten children's social interaction with peers at the computer area in a public kindergarten classroom?

The findings of this study have the potential to provide information to teachers who want to integrate computer technology into their classrooms in developmentally appropriate ways, to software designers who want to develop educationally meaningful software programs for young children, and to policy makers who are open to changing their legislation and state standards regarding technology use. Teachers may gain insights to help them understand technology integration and to know how to scaffold young children in order to support their knowledge construction through social interaction. Software designers will be able to modify the design of software in order to provide creative and interactive programs fit appropriate classroom curriculum. Policy makers will be provided information that will inform their shaping of educational policies in terms of technology integration.

Theoretical framework

Most of the research about technology in education has had concerns about the effects of computer usage in early childhood education on students' social development (Armstrong and Casement 2000; Colker 2011; Cords and Miller 2000; Maynard 2010; Yelland 2011). One research study reported that young children tended to interact nine times more at the computer than at the manipulative area (Haugland 2005). Another study found that computer activities connected with story telling activities enriched children's social interaction (Lin 2012; Wang et al. 2010). Therefore, the concerns about computer usage in terms of isolating children are not persuasive (Grey 2011; Haugland 2005; Wohlwend 2010).

The National Association for the Education of Young Children (NAEYC)'s Position Statement on Technology and Young Children (2012) asserted that computer technology in early childhood education should be used in developmentally appropriate ways. Computer activities can promote young children's problem solving, critical thinking, and decision making skills; creativity, language, and social abilities; and their self-esteem (Maynard 2010; Stephen and Plowman 2008; NAEYC 2012). Thus, an important question is not whether or not computer use is appropriate for young children, but rather to what extent do computers promote social interaction and how do we best facilitate that.

In addition, social interactions that computers promote appear to be more than just exchanging emotional expressions and information. Rather, the kinds of social interactions supported by computers include the co-construction of knowledge in educationally meaningful ways. Vygotsky stated that learning and development is a social and collaborative activity (Vygotsky and Luria 1994). Therefore, this interaction is not merely exchanging information but also accumulating and accommodating their prior conceptions through the interaction. Thus, an important consideration is whether and how computer activities and related interactions in the classroom computer area enhance social and collaborative learning that is supportive for children's meaningful learning and development throughout the curriculum.

Moreover, research studies have reported that children were more likely to interact with one another when they were using computer technology as a tool of meaningful technology integration (Lin 2012; Wang et al. 2010). Technology integration means that computer activities are connected with other activities in a classroom based on the curriculum. When children use computers for entertainment including games or to create simple drawings, they tend to work alone and do not respond to their peers' conversations. But, when children explored computer programs related to some ongoing classroom project theme, children tended to interact more with one another and exchange information related to computer tasks as well as to the overall themes. Therefore, it is valuable to explore how young children are interacting when using computers as integrated tools for learning.

Studying conversations might be one means for examining how young children use computers as tools for developing questions, concepts, and theories about their emergent learning in technology-rich classrooms. The quality of interactions children engage in around computers is more important in terms of contributing to children's cognitive learning and elaboration through the peer to peer scaffolding, arguments and conflict resolution. More research is necessary in order for us to more fully understand how the kinds of collaborative social interactions young children have at computers supports higher-level thinking and encourages knowledge construction.

Interactions are not just the exchange of emotions and information, but also enhance children's learning. Interactions provide children with opportunities to express different thoughts and guide them to solve problems based on negotiation. If children are provided with a great variety of problem-solving situations through their interactions with more advanced peers who can provide help and support, children's cognitive structures can be changed and enhanced (Cullen and Greene 2011; Elkind 1985; Haugland 2005). Theories of constructivism emphasize social aspects in learning situations. When children investigate, explore, discuss, and voice their opinions to one another, they practice expressing their thoughts clearly enough so that others can understand them. They also gain experience in perceiving the way other people think (Maynard 2010). "The intrapsychological thought processes influence on individuals' internalization of the learning" (Hyun and Davis 2005, p. 120). Interacting with others in a social learning context encourages the engagement of more advanced thought. If learning activities are well supported by the scaffolding, higher levels of learning are likely to occur (Siyahhan et al. 2010; Zevenbergen 2007). It is explained by Vygotsky's theory that learning and development is a social and collaborative activity (Vygotsky and Luria 1994).

Many research studies on technology and learning have focused on how to use computers to support learners' social, linguistic, and cognitive development (Lin 2012; Yelland 2011). Children's interactions while working at a computer may include a wide range of social skills, including conflict-resolution, problem solving, and cooperative learning strategies. When children are working together, they are more likely to ask their peer than the teacher for help (Haugland 2005; Gimbert and Cristol 2004). Children who learn to use simple word processing programs are confronted with their own thought processes; a process that can be beneficial for social and cognitive development. The computer, then, can provide another avenue for children to engage in the "reflective abstraction" that encourages the formation of new knowledge construction (Elkind 1985). This is clearly seen when children are working with computers, because in these situations conflicts can seldom be solved with physical force or through social dominance (Hyun and Davis 2005). In such situations, children are more likely to interact with one another in positive and meaningful ways.

However, Clements and Sarama (2007) reported that constant teacher presence can inhibit children's interactions with each other. Greiffenhagen (2012) also explored teachers' role in CSCL learning environments and revealed that excessive teacher monitoring diminished group discussion. Therefore, teachers should understand children's different kinds of social interactions at the computer area in order to scaffold according to their different social behaviors. As mentioned earlier, children often ask each other for help. Children may sometimes gain a greater understanding of the computer and the material if they can work together with their peers without adults' assistance.

Based on Elkind's (1985) study, several types of interactions were identified as follows; (1) task-related interaction, (2) method-related interaction, (3) socio-emotional interaction, and (4) miscellaneous off-task interaction. Children's verbal communication through computer-supported collaborative learning was examined in the Spoken Language and New Technology (SLANT) project. Hyun and Davis (2005) examined the positive effects of computers in early childhood education on enhancing "*exploratory talk*" (p. 120). According to the study, children's cumulative talk in a computer area encouraged exploratory talk. In this study, exploratory talk is important to support children's construction of knowledge because it allows children to expand their learning experiences and knowledge. This is based on Vygotsky's theory of the Zone of Proximal Development (ZPD) (Hyun and Davis 2005). The ZPD refers to the distance between children's independent performance, the level at which children can perform alone or unassisted, and children's assisted performance, the assistance provided by adults or more competent peers (Vygotsky and Luria 1994).

Roschelle and Teasley (1995) proposed the construction of shared knowledge in collaborative problem solving and this study supported that computer technology as a way to promote Joint Problem Space (JPS). JPS is a virtual space where students are able to manipulate some artificial materials in order to examine their hypothesis and then to see the results of the experiment. The research concluded that students were more likely to interact with each other when working collaboratively in a computer area and computer provided JPS for students to explore their thinking collaboratively. Students had an opportunity to experience meaningful knowledge construction through computer-supported collaborative learning activities. This feature supporting students interactive knowledge construction through computer activity in a collaborative learning environment are not "inherent in the machine but what people (students) do with the machine that determine… (p. 18)." This kind of shared knowledge is very important to produce rich collaboration that leads productive education (Gelmini-Hornsby et al. 2011).

Hyun and Davis' (2005) study explored five- to six-year-old kindergartners' conversations and emerging inquiries with computers in a technology-rich classroom. Young children tended to ask educationally meaningful questions, which is emergent through computer activity and interaction with their peers at the computer. This result was supported by Dillenbourg and Evans' (2011) study, which examined interactive tabletops in education and educationally meaningful experience could be performed through multiple modes of communication in the computer-learning environment. This finding is supported by Perez-Sanagustin et al. (2012) study that computer technology is meaningful for enhancing learning purposes. Q2

Despite the prevalence of computer technology in early childhood education settings, many teachers and children have been with struggling with how to use computer technology in educationally meaningful ways (Fesakis et al. 2011). In order to seek a solution for teachers and children, this research investigated how young children worked together at the computer in a kindergarten classroom and how young children might gain educationally meaningful knowledge construction by interacting with their peers.

According to Vygotsky's theory, young children learn something not by themselves, but by interacting with others, friends,and adults. Also, many concerns about computers in early childhood education are related to the possibility that they might isolate children, or keep them from interacting with others, making social interaction an interesting topic to explore. In order to understand young children's perspective, rather than a teacher's perspective, this study will closely observe young children's play at the computer by focusing on their social interaction with peers.

Method

Participants

This study was conducted in one Korean public kindergarten classroom located within a public elementary school in Seoul, South Korea. This classroom was selected as an observation sample because this setting was constructed according to developmentally appropriate practices based on NAEYC's position statements, especially related to technology use and integration. Thirty children were solicited for the study and parents of 28 of these children signed the informed consent forms to allow them to participate. In this study, the researcher observed and interviewed 28 children, 12 boys and 16 girls, nine 5-year and 17 6-year-old children, as they played at the computer. The children are primarily from middle-class families, with a few from upper middle-class families. The researcher observed the children for 3 months in their classroom during the free choice activity time. This classroom has two lead teachers and they work alone each day by taking turns. Teacher A has 7 years of teaching experience in private and public kindergarten and teacher B has 5 years of teaching experience. Their teaching practices tend to be more constructivist than traditional, as determined by interview and observations. The researcher interviewed the teachers eight times in this study.

Settings

There were no CD-ROMs or software programs located in this classroom. So the internet and some accessory programs, such as a drawing board program in Windows were used by the children (See Figs. 1 and 2). Two computers were located side by side and between

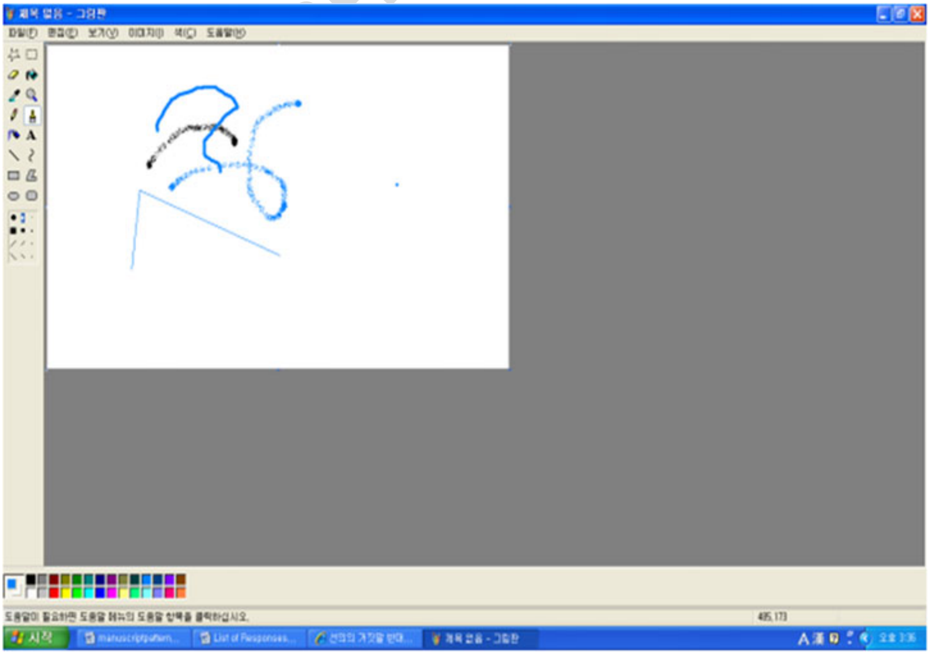
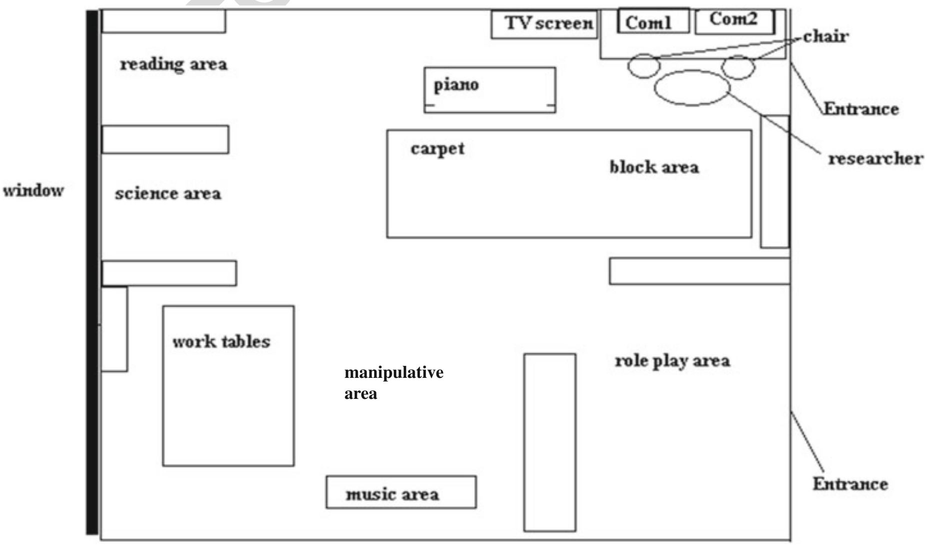


Fig. 1 Drawing board program

Fig. 2 Internet portal site for kids

computers there was a partition so children stood up in order to see the other computer screen.

There was one chair for each computer, but sometimes two chairs were allowed at a computer (See Fig. 3). There was no printer or scanner in the classroom. After work, teachers



Q3 **Fig. 3** Edu-care classroom

saved children's artifacts and then printed them out from a printer in the teachers' room. One computer screen was connected with a big TV screen in the classroom, and this setting helped teachers to monitor and control children's computer activities, especially internet searching.

As indicated, the computer area was located in a corner of this classroom, just next to the front door. The children used the computers during free choice activity time, which lasted from 50- to 60-min each day. The researcher observed children's computer usage in the computer area. On the computer table, there was a shelf without any CD-ROMs. Also, there was a sand clock on a table, and the teacher or children set the time to limit the amount of using time, 15 min, used by a child or for taking turns with other children.

The learning goal for computer activities in this classroom was technology integration, which means computer activities were related to the classroom on-going curriculum. Specifically, the learning goals for computer activities were divided for two different groups of children. One was for the group of children who were very competent using computers, and the other was for the group of children who were not familiar with computer activities. For the expert group, the learning goal for computer activities was to extend their learning experiences and their various ways for expressing their thinking through technology. On the other hand, for the novice group, the learning goal for computer activities was 1) to be friendly with computer equipment, and 2) to experience computer technology. Upon these two different kinds of learning goals, teachers designed different computer activities.

Rules for the computer area

In this classroom, teachers and children made rules for the computer area. Children could play at the computer area for 10 min. Usually a child might work at a computer, but sometimes two children could work at a computer when they wanted to. If a child only observed friends' activities at the computer without participating in other activity areas, it was not allowed because each child had to choose to work at least one of other activity areas. This rule seemed to keep children from interacting with one another.

In this observation for data collection, the researcher focused on child-to-child social interaction, but sometimes, if necessary, teachers' roles were included in order to explain what was seen in terms of the child-to-child social interaction. For example, when child A was observed to stop interacting with child B, it was noted that it was because the teacher had interrupted child B. In cases like this, children's social interaction was affected by a teacher's interruption, and the researcher mentioned it in a field note.

Data analysis

In this study, a qualitative inquiry was used for providing more detailed and specific information about one or a small number of events. Therefore, this qualitative inquiry could find somethings that quantitative research would miss through quantifying collected data. Because of the focus on one or a small number of cases, it was hard to end up with conclusions that were necessarily applicable to other settings in qualitative inquiry. Rather, this qualitative study made inferences based upon a phenomenon that was contextualized.

> "The place and time in which the investigation takes place is one context, but naturalistic inquiry can also seek to relate itself to a larger context of research related to that which is being studied (Lincoln and Guba 1985, p.35)."

There were three data sources that informed this study: (1) observations of children's social interaction with peers at the computer area, (2) interviews with the children and teachers, and (3) collections of relevant documents, work samples, and artifacts related to curriculum and computer technology. Observations were made during the children's computer usage for 5 weeks, 5 days a week, for 60 min per day. The teachers were interviewed five times. The interview questions were about how to scaffold children to interact with each other at the computer in this kindergarten classroom, the interaction between children and peers, and teachers' interpretation about children's interaction at the computer. Much of the data collection process involved the use of audiotapes. The field notes, related documents, and teacher interviews were reread and notes and comments were written in the margins of the pages. These notes and comments were grouped, compared and identified across all data sets.

As a result of this process, initial categories and codes emerged which were noted and categorized. Initial categories and codes were attached to chunks of data and used to organize the group of data. Young children's social interaction which evolves to knowledge construction is assessed based on whether young children's social interaction at the computer produced young children's attempts to apply new methods and strategies for solving the problems or not. If young children tried to apply a new method for their problem solving process, the social interaction is assumed to contribute to the construction of educationally meaningful knowledge gains. Yet, if young children did not change their ways of problem solving and if there is no improvement of problem solving strategy, this social interaction is assessed as no knowledge construction occurred. Trustworthiness can be considered through triangulation, intensive observation and peer debriefing.

Results

The research question addressed the patterns of young children's social interaction with peers at the computer. The patterns identified were categorized as follows: parallel play, simple verbal conflicts, sociable interactions, knowledge gains through positive process, knowledge construction through negative process, and non-verbal communication. Each of these is described on Table 1.

Quantitative data

These patterns were categorized from collected data, field notes from observation, interview notes, and artifacts children created during computer activities. This study is mainly a

t1.1 **Table 1** Patterns of social
t1.2 interaction

	Patterns of Social Interaction	Explanation
t1.3	Parallel play	• similar to regular play situation
t1.4		• monologue
t1.5	Verbal conflicts	• simply exchange words of disagreement without information
t1.6	Sociable interactions	• simply exchange words of agreement without information
t1.7	Knowledge gaining through positive process	• exchanging information positively
t1.8	Knowledge construction through negative process	• exchanging information through negative conflict
t1.9	Non-verbal communication	• observing, imitating, triggering to new interest

qualitative research; but in this section, some quantitative data are included in order to explain the engagement of computer-related work versus other activities, the amount of social interaction in collaborative ways versus working alone, the frequency of each pattern of social interaction, and the duration of each pattern. In order to understand the result of this study based on overall classroom activities including many other interest areas in classroom curriculum, the above frequency and amount are reported.

The total amount of social interaction (Table 2) was counted as a percentile. During the free choice interest activity time, children choose two or three activity areas to engage in. In the computer area, children's collaborative learning occurred 68.4 %, and children worked alone at the computer for 31.6 % of the whole time. In contrast, in other activity areas, children tended to work collaboratively for 53.9 % and worked alone for 46.1 %. In all the activity areas, collaborative learning occurred more than solitary learning activity. Young children's social interaction is observed frequently in all the areas, but especially in a computer area, children tended to interaction more than other areas.

The frequency and duration of each pattern of social interaction are shown in Table 3. From field notes, 946 times of social interaction were observed. Through coding the collected data, the frequency times of each patterns happened were counted. Sociable interaction occurred the most as 179 times. Among CESI, knowledge gains through positive process happened at 181 times, while knowledge gains through negative process occurred 169 times and non-verbal communication 158 times. The duration of social interaction was calculated based on the total amount of time, 60 min, of young childrens' use of the computer in the classroom. The duration of knowledge gains through negative process was the most at 23.2 min per 60 min. Children took time to resolve conflicts and made solutions about it, and therefore this pattern of knowledge gains through negative processes took more time than others. CESI, knowledge gains through positive processes was also took much time and non-verbal communication was least among CESI. In addition, the duration of parallel play was similar to the one of non-verbal communication. Overall, CESI showed much time at the computer in this classroom.

Parallel play

The first discernable pattern identified was parallel play. The most prevalent concerns about computer technology in early childhood education are the impacts it may have on social and emotional development (Lee and Ginsburg 2009). In response to this concern, some scholars have examined the potential benefits of computer use on children's social and emotional development. Many research studies have demonstrated that children generally prefer not to work alone at the computer; instead, they often choose to work in pairs or in small groups Q4 (Svensson 2000; Wolfe and Flewitt 2010; Yelland 2011). In the classroom in this study, children primarily worked independently without interacting with peers when using paint programs. But, even in this moment, children noticed that their friends were working beside them. This is more like the pattern of parallel play, which we can easily find at a regular play situation for this age group.

Table 2 The total amount of social interaction (%)

	Collaborative learning	Solitary learning
Computer activities	68.4	31.6
Other activities	53.9	46.1

Table 3 The frequency and duration of each pattern of social interaction (frequency=times/total interaction, duration=minutes/ 60minutes)

	Frequency(total 946)	duration
Parallel play	152	18.0
Verbal conflict	107	8.5
Sociable interaction	179	11.2
Knowledge gaining through positive process	181	21.0
Knowledge gaining through negative process	169	23.2
Non-verbal communication	158	18.1

Many social interactions are meaningful and helpful. But, occasionally meaningless interactions were also observed throughout this observation - "meaningless interaction" is an interaction that did not deliver any information to a peer through exchanging words and so on while a meaningful communication had not occurred.

Child J: Uh! How did you do that? How?
Child G: hahahaha! I don't know! Try this!

Also, sometimes children talk without exchanging words, they just talk to themselves. This pattern is similar to parallel play during any regular play situation. In this scene, children were using monologues.

Child A: (saw computer A screen and sat) Isn't this G's work? He did it yesterday, right?
Child D: (keeps working on computer B) This looks funny, hahahaha!
Child A: G hadn't finished it but I will do it!
Child D: I am a spiderman here, pi-yoong! (scribbled so many lines on drawing board and this seemed like a spider's web)
Child K: What are you guys doing? (no answers from A and D. Child K passed by.)
Child A and Child D were sitting side-by-side at computers. Both children concentrated on their own activities, and did not pay attention to each other's talking. This interaction is natural and it is a play pattern known as parallel play.

Verbal conflicts

Second, simple verbal conflicts were observed but it was not a negative conflict. Simple verbal conflicts mean that children had a kind of negative interaction without exchanging any information or knowledge gain. It was also one pattern of social interaction observed in this present study.

Child G: (cut a dinosaur picture the other child did) Isn't this cool? Huh?
Child E: That's nothing~!
(At the back of Child G, Child E was looking at this. E Kept watching and G kept changing dinosaur pictures by controlling mouse and keyboard. Eventually, E tried to touch mouse)
Child G: No! (Child E stopped touching mouse and kept watching what G was doing. Ten minutes later Child G went out.)

Child G: Now you do it!
(Child E started working on the computer screen)

While Child G drew the big picture of dinosaur, Child E sent a negative reaction on Child G's artifact. After Child G went out, Child E drew and colored the rest. Negative reaction is not always problematic, this also is one of social interaction that children can create a better artifact. Based on the interview with Child E, the researcher realized that children do not seriously respond to their friends' negative reactions. Child E answered that he was very happy to work on Child G's artifact, and Child E did not recognize the "No" comment that Child G had told him. He just watched and after having his turn, he enjoyed working on this, he replied.

The more important point is not that there was a conflict between children; even conflict in social interaction with young children can lead to knowledge and skill development. The question is whether the conflict observed in this study triggered any better output from the children. When children have conflict, it can cause them to work through their problems in a constructive manner. Even though in this observation, any educationally meaning information which leads to knowledge construction between Child E and Child G was not exchanged, this simple negative interaction is categorized as one of the patterns of social interaction.

Sociable interactions

A third pattern observed was that involving sociable interactions. Sociable Interactions in this study meant that children interact in a positive way without exchanging any information or knowledge gain. Children tend to enjoy the computer content with their peers. Children saw each other and smiled together when encountering funny or humorous scenes on the computer. This situation was as follows: Child I, C and G were playing at the computer area and Child C freely saw Child I and G's screen. Child I was looking at some 'story book' program on Yahoo Ggu-reo-gi, and Child G was also looking at a 'story book' program via the internet. When I's screen showed something funny, Child I and C looked at each other and laughed together. Also, when Child G's screen showed something interesting for Child C, C turned his head and laughed together with Child G. All of them were happy at that time because they were friends who could share the happy moment together. Right after this observation, the researcher asked Child C the following question: "Which was more delightful for you, playing with the computer by yourself or with your friends?" Child C answered that working with her peers at the computer area was much more interesting than working alone.

In particular, an important point about young children's social interaction is that a shy or lonely child who is not doing well at the other areas of the classroom can be an expert at the computer. In this study, children who appeared to be particularly expert at computer technology were willing to be problem solvers or helpers for their friends at the computer area.

Child J: (Child E tried to imitate what Child J did, but E couldn't easily do it) Did you do it? Or not?
Child E: Huh! I can't. (because E selected white color on white page, the palette setting caused the problem)
Child J: Hey! Cause you chose white color on white page! That's invisible.(J changed E's color palette setting) See! Try this!

Child E: (started drawing with the colors)

Child J was a calm and quiet boy who usually played by alone or with one or two friends. He was not such an expert in other areas, but at the computer, he was a good helper and problem solver. He was very active there and many friends asked Child J to help them when encountering any technical problems. When we consider a computer as one of many activity areas inside kindergarten, a child who is not so talkative and outgoing in other areas can be a more active and eligible person at the computer and vice versa. Therefore, a child who is passive in some areas has the opportunity to become a person who is able to provide any helps to his friends. This might affect his good self-esteem.

Knowledge gains through positive process

There was also a pattern of knowledge construction through positive interaction processes that we identified. This pattern means that children exchange meaningful information and finally they have more knowledge construction through this interaction. In addition to the drawing program, children in this classroom did writing activities on the computers. Mostly, children were novice writers, so they needed their friends' help composing words on the computer screen. Children tried to help their friend sound out words and recognize letters, writing what children said on a separate paper to help children to then type those sentences onto the computer screen. When considering kindergartener's developmental stage in terms of literacy, it is important to note that young children are more likely to recognize whole words before they can spell them out. Young children can successfully use computers for word processing in emergent literacy programs.

Child B: (type Um-Ma(mom in Korean) How do we spell 'Gang-A-Gi (a dog)?'
Child C: Gang-A-Gi is G, A, and eung, A, G, A and G. (teach each spelling)
Child B: (typed Gang-A-Gi) How do we make a space?
Child C: You go back and make a space here…press this space bar. What's the other word you want to write?
Child B: Um…..There's a Ga-We(a scissor) (pointed a letter of a scissor on a classroom wall)
Child B: I saw a Ga-We. (typing Ga-We) Ga, We. (went to teacher) I'm done. I did it.
Teacher: Wow! We'd better go back to a space bar here… Just push. You think it looks better? What do we put at the end of a sentence?
Child B: Period. (typing '.')
Teacher: OK! Then you need to sign.
Child B: (typed his name on screen)
Teacher: (saved and printed) I have to go get it. Great! (went to a teacher's room to get it)
Child B: (stood up from the chair and said "yes!" with a smile and punching his right hand up)

Children who write more often with computers as their skills advance are likely to take increased pride and confidence in their writing (Wohlwend 2010; Wolfe and Flewitt 2010). Computer writing activities provide many possibilities for emergent literacy and emergent writing for early childhood classrooms. In this classroom, two children worked together and completed writing by helping each other.

Teacher A said that when children write on a computer, they want to print it out and show it to mom when mom comes to pick the child up. Children at this age love to type words and sometimes they bring books or other print material from reading area or manipulative area in order to type the words. Through recognizing the whole word at a time, children gradually learn how to write and read. They also loved to draw their names on screen.

Another pattern that was identified as knowledge construction through positive interaction was of children's social interaction with peers in which there was cumulative knowledge construction by collaborative work. Children started working on the previous artifact that their friend had been working on at the computer. As time went on, this kind of cumulative work became more delicate and complex. This might be called cumulative knowledge construction with peers.

When Child G went out of the computer area, Child C started to work on the computer that Child G had just finished. Sometimes Child C started a new work by closing what Child G had done. But in this observation, Child C started his work by adding to the previous outcome of Child G's work without closing G's screen. Finally, this work became the whole class's work, and all classroom friends joined to add or fix some parts on their class work. This cooperation brought them very elaborated and complex artifact children added and fixed what other children had done before.

Child G: (made blue print for new building he would build on at block area)
Child I: Wow! What are you doing?
Child G: This is going to be my building at block area.
Child I: Cool! Let me try that.
(Child G concentrated on that drawing work while Child I was looking at it)
-After a while, a teacher introduced this blue print to all classroom children and she suggested that they add to it or to fix it as other children wanted. This became the project that would be going on in this classroom.
On the next day,
Child C: G's work! I will work on it.
Child D: Add rooms here!(pointed to screen) No, here! Cause I need a room for my dog. (Child C tried to make a room on that point as Child D mentioned)
Child F: This doesn't look like a stair. Let me try this. (After Child C's work, Child F sat and started working)
Child A: Why don't you guys color on it? This blue print needs different color lines for different rooms. (changed the color of lines, windows changed to blue, rooms changed to green, door changed to yellow…)
(Teacher reminded all children to do this work if they wanted. And then many children worked on it and the work became more complex so it seemed like the grown-up had done this work.)

Through this cooperation process, this class made a big blue print and it contained many necessary details and important ideas on it. If a child worked alone, his idea would stop on that point, but when many children added more ideas and then built up more and more, they all shared many various points of views and ideas. At first, the blue print briefly included some lines that made a building, but as time went on, this blue print was getting complex and detailed. One child added a nice big window in front of building and the next day, the other child fixed a steady door to a moving entrance door accompanying with that window. In this way, the blue print was getting more sophisticated. This experience allowed them to think differently and more creatively. Young children's social interaction with their peers at the computer area became connected with other activity areas and became more educationally meaningful.

Through children's social interaction with peers, children got interested in computer activity and got useful information as well.

Child G: (on background screen, found a dinosaur picture and drew on it, Teacher B prepared many pictures that children could choose and draw on this. A teacher tried to expand children's drawing activity at the computer)
Child I: (saw G's screen) Hey! Where did you get it (dinosaur)?
Child G: already in this computer screen, but not yours.
(saved pictures are different between computer A and B)

Seeing and talking to children triggered more ideas about what to do with computers and the information from peers guided children to work on new activities on the computer. Exchanging information and triggering new ideas and interests were all influenced by young children's interaction with peers. Moreover, children's social interactions at the computer helped them learn about the two-way give-and-take of relationships.

Child E: (working on his computer)
Child I: Hey! It's too small! Let me make this bigger!
(selected that portion with net function and tried to enlarge it. But this net function is for cutting that portion. So just cut and moved it.) Why it's not working?
Child J: (J had been working on the other computer) I'll do it. Not easy to erase with this!
Child I: this isn't the right tool! Let me try! (Child I selected the right tool and fixed it)

Throughout the process of trying to solve problems, even if the problems were not solved, their trial and error attempts were also very important. It allowed them time to think deeply about problems and solutions. Elkind (1985) reported that social interaction might decrease children's enough time for reflection by providing direct helps, but in this present study, children had the opportunity to figure out and reach for the solution of the problem through their social interaction. While solving problems, children developed critical thinking and had a good opportunity to examine many different perspectives with friends, and negotiate to find out a better solution. Sometimes, even though children are not able to find out the best solution, the process they engaged in is a valuable and meaningful experience for them.

Knowledge gaining through negative process

Another pattern of children's social interaction involved knowledge construction through negative interaction. Knowledge construction through negative interaction means that children exchange information through a negative conflict. At this time, the term "conflict" does not mean the fighting between children, rather this means that there were some kinds of disagreements between children and two children had different point of views about the solution for the problem. Through this interaction, children tended to figure out the best solution they could apply for solving the problem. This information includes knowledge information about computer software contents or technical information of computer usage, such as how to use a specific tool related to the computer.

Child I: Hey! How did you do this? What made it like this?
Child I & G: (all laughed)
Child I: G! Eraser is really huge. (mistakenly selected big eraser)

Child G: I! How? How? Oh! Me, too. Me, too. My eraser is so big, too. (mistakenly clicked lens function) Ha ha…
Child I: How can we use lens like you?
Child G: This one? (showed by clicking the tool on G's screen)
Child I: Not working for me.
Child G: Here! (stood and pointed to I's screen)

Child I and Child G explored computer tools in their own ways, and each of them found out new methods of using the magnifying eraser. Even though they found out different methods (Child G magnified the eraser with the lens but Child I changed the eraser from a small one to a big one), they both tried to share their findings with their friend and to examine the effects of each newly discovered method. Moreover, when Child I could not find the exact tool that Child G was trying to teach him to use, Child G tried to teach it by standing and pointing it out on his friend's computer screen. Child I answered at the interview that by figuring out the way to use lens, his finding was different from friend's finding. After sharing and teaching each other, he felt he was proud of himself.

There is more than one way to reach any particular goal. Children learn that there are various ways to reach goals through their interaction and exchanges with their peers who discover different ways to solve those problems. Through this interaction, children's knowledge becomes deeper and wider. Computer technology is a medium for children to enlarge their knowledge structure.

Non-verbal communication

Finally, a pattern of social interaction that involved non-verbal communication was observed. Non-verbal communication means that children observe and imitate friends' computer screens without talking, and through this imitation, children gain new interestt. Young children's non-verbal interactions also expand children's knowledge and information. This non-verbal interaction doesn't occur through talking or exchanging information, and therefore sometimes this interaction seems not to induce any interactivity among children. However, children were surely gaining and constructing some kinds of learning through the amount of this time.

Child J: What's this? Wow! So many cool stuffs!
Child E: (stood up and saw Child J's screen. Then went to his computer again and clicked the same image)

Even though there was non-verbal communication, or at least no verbal exchange, information was delivered about where the "cool" images were. Child E connected to the information he got from his peer. In order to develop children's interests about computer activity, this activity should go from concentration to learning. Through this process, children connected and constructed new or revised knowledge structures by this particular pattern of non-verbal interaction that was seen repeatedly.

For example, teacher B said that some children seemed not to be interested in the computer activity, but one day, the teacher realized that those children kept watching and observing what other children were doing at the computer without talking. At first, she tried to keep them from going and watching the computer activity because she thought that those children are not doing anything, just watching without any thinking. Yet, one day, one of those children selected the computer activity. So Teacher B watched what the child was doing at the computer area, and she was astonished that the child tried to imitate what the child had watched for a long time. The child was taking what he had learned by watching, and applying it to his own activity. Teacher B said that sometimes children seem not to do anything, but inside their mind a certain kind of learning seems to be occurring.

Swaminathan and Wright (2003) said that computers should "support and extend children's learning, not just entertain or occupy them" (p.139). That can be the distinction between developmentally appropriate programs and developmentally inappropriate programs. When children are using writing programs or the Internet activities that are inherently open and which tend to support and extend children's learning experiences, they were more engaged. But when they just explored colors in the drawing program, they seemed to just be entertained or occupied by the computer. It is important to note that, even if the software is open-ended, children can use it in ways that do not extend or support learning. Also, developmentally, although kindergarten children can click and drag using a mouse without any problems, when they are just clicking randomly, they can easily click different icons unintentionally as well.

Sometimes, children tended to click mistakenly, but this is not always problematic. According to Elkind (1985), children need to have enough time for reflection without getting direct help from their friends. Therefore, solitary work time, even though it seems like a child is just making a mistake by random clicking, is truly necessary in order to provide reflection moments by trial-or-error.

CESI (Cognitively Effective Social Interaction)

Young children's social interaction patterns were categorized as six types. Among these six patterns of social interaction, CESI (cognitively effective social interaction) was knowledge gained through positive process, knowledge gained through negative process, and non-verbal communication. Three out of six patterns of social interaction, 1) parallel play, 2) verbal conflict, and 3) sociable interaction, were the types of young children's social interaction observed at the computer but these interactions did not evolve to knowledge construction and knowledge gaining because there was no strategic improvement of using computers or no artifacts improved technologically or artistically through these three interactions.

However, the last three patterns of social interaction, 4) knowledge gainied through positive process, 5) knowledge gained through negative process, and 6) non-verbal communication, were connected with young children's knowledge construction. After these three patterns of social interaction, young children tended to apply a new way of problem solving methods and improve their ability to create better artifacts by using a new strategy they gained through these three patterns of social interaction.

All six patterns derived from this study are equally important for an educator's perspectives but social interaction evolves to knowledge construction to be encouraged at the computer in early childhood education settings. Teachers, software designers, and policy makers are supposed to consider different patterns of social interaction, find out how to scaffold young children's CESI in early childhood education and seek the solution for supporting knowledge construction through educationally meaningful social interaction

Discussion

Computer technology can be a positive learning tool for young children when it supports children's social interactions with peers, and promotes knowledge construction and cognitive development through this interaction. Most likely, these kinds of social interactions with peers occur in technology-integrated ways when children are working in collaboration (Clements and Sarama 2007; Lin 2012; Specht et al. 2002; Yelland 2011). Therefore, a study of children's social interactions with peers in kindergarten classroom can be meaningful (Gimbert and Cristol 2004; Fesakis et al. 2011; Haugland 2005; Wang, et al. 2010). It would be important to examine how to scaffold young children's cognitive learning through supporting their social interactions in developmentally appropriate learning environments.

At the computer, children might see electronic storybooks or songs via the internet, and this was done largely without interacting with others. Therefore, it was easy to see why people might think that computers isolate children. But, as a matter of fact, it does not have to be this way. Computer activities were supposed to be designed in such a way as to encourage give and take among peers. Even on the Internet, information could be accessed that might be communicated with friends when others come by or when others show interest in it. When children engaged in Internet content, however, teachers or adults should pay attention and make sure they do not enter any harmful sites. When children were exposed to any harmful sites via the Internet, they might absorb any information provided by Internet contents without any critics. This might cause unintended and non-educational influence, for instance, imitating aggressive actions or anti-social behaviors. Children might be affected by others very easily, and therefore children's computer usage should be carefully monitored by adult teachers.

From this research, the patterns of children's social interaction with their peers at the computer were discussed. Based on the patterns of children's interaction, the researcher identified and understood the current status of implementing computer technology, can propose possible solutions, and can consider future directions.

The patterns of children's interactions were categorized as follows: (1) parallel play, (2) simple verbal conflicts, (3) sociable interactions, (4) knowledge gained through positive interaction process, (5) knowledge construction through negative interaction process, and (6) non-verbal communication.

Computer technology used in early childhood education settings does not isolate children and it supports young children's social interaction with peers in developmentally meaningful ways. Young children are interacting with their friends happily and meaningfully, just as interacting in other activity areas such as block areas, manipulative areas and so on. Based on the findings, exploring the ways teachers can support young children's social interaction at the computer area in developmentally appropriate ways is more important point for in the future study.

Appendix A. Sample Excerpt from Observation

Feb. 3. 2008 (4:00–5:00 pm) Edu-Care classroom (Teacher A)

Child ID	Activity	Etc.
Child I	• Drawing board program	Com1. I
	• Drew people and many lines, and then erased lines…	Com2. C
Child C	• Upside down the sand watch	

Feb. 3. 2008 (4:00–5:00 pm) Edu-Care classroom (Teacher A)

		Com2. D&F stand back
	• Child D & F in. looked C's screen	
Child D	"You don't mean to color black there?"	
Child F	"Why? It's cute!"	
Child C	"A dinosaur is always cute!"	D&F out
	• Drawing a dinosaur. Filling out with colors.	
	• Saved in "My document-Our works"	
Child D	• D came in.	
	"C drew a monster!"	
	• D, went out.	
Child L	"What are you doing?"	
	• Nobody answered and L went out.	
Child C	"all done!"	
	• Saved a file name[ltkejowsksg]. just typed anything, but it was not a word.	
Teacher A	"What were you doing?"(to Child C)	
Child C	"A monster!"	
Teacher A	"A monster?"	
Child C	"Yes!"	C out
	• (to Child I)"Hey! [ltkejowsksg] is mine!"	
Child I	• Looked at Child C's screen, "Hahahaha~!"	
	• Now Child I started imitating Child C. drew people and a sun. filling out with colors. Mistakenly all screen was filled with blue. (I intended to color only people with blue, but a small gap allowed colors to spread to all screen)	
Child K	"Hey! How come everything is blue! Hahaha…"	K passed by
	• Child I laughed together.	
Teacher A	• Without C's request, Teacher A saved C's work in a new folder [Drawing board save].	
	"Next time, you can find your file here!"	
	<Teacher A saved it so fast. The interaction between a teacher and a child was not occurred.>	
	• Saved Child I's work also in this folder that Teacher A had just created. A file name is "Child I's name"	
Child I	• Drew many zigzag lines, and then erased with an eraser tool. With a spray tool, started drawing a face.	
Child C	• Drew a house and filled out with colors again.	Child C out
	• Saved this in My document-our works rather than a new folder [drawing board save] that Teacher A had created. A file name was [ghlrkgkrkrqqqqqgkskm] "I'm done!"	
Teacher A	"I! Your computer time is over, right?"	
Child I	"huh?"	
Teacher A	"Child C & I started together, so finish computer work now."	C&I out
Child D & F	• Went to com1 together.	Com2. Child L

Feb. 3. 2008 (4:00–5:00 pm) Edu-Care classroom (Teacher A)		
	"Teacher! Can we work together?"	Com1. Child D
		Child F stood back of D
Child D	"I will draw universe!"	
Child F	"Ok! Universe on a black background!"	
	• Brought a chair and put it next to Child D's chair. Child D&F are both in front of com 1.	
Child D	• Drew many big and little circles on black background	
Child L	• Scrolled up and down very well. Searching internet.	
	"Where is Dora? A-Hu.."	
Child D	• Stood and looked at Child L,	
	"You shouldn't play games in that computer! There (pointed at L's screen)! Story Book!"	
Child G	"Yahoo Hogan! Enter Yahoo Hogan!"	Stood back of Child L
Child L	"I'm looking for Dora Dora!"	
	• Clicked many things on the left. Entered Bookey story book, but didn't like it. Selected Korean traditional story.	
Child D	• Lined Saturn.	
	• Child F got a mouse again and then drew lines continuously. Child F put her name card on a computer body.	
	"brown?"	
	• Child D filled out a screen with a black.	
Child F	• Filled out with brown and finally completed Saturn.	
Child G	"Oh! It's Saturn!"	
Teacher A	"It seems Saturn!"	
Child D & F	Filled out every blank with black.	
Child D	"Let's name it 'Saturn'"	
Child F	"Ok! Save as a different name! my pictures! A file name is 'Saturn' !"	
Child D	"Teacher! After writing a title, go to a windows background screen, right?"	
Teacher A	"Right! Go to a background screen and then open "drawing board save" and saved it as [picture Saturn – Child D & F]. Let me write a helper Child F next to Child D's name."	
Child D	"Here! Here! With this spray tool (pointed with D's finger)!"	
Child F	• Clicked a spray tool with a mouse.	
Child D	• Erased some circles with a spray tool.	
	• Looked back. To child G,	
	"Are you looking at this?"	
Child G	• Played in a block area. "Huh?"	
Child D	"Looking at THIS?"	
Child L	• Selected Story book.	
Child D	• Stood up and looked at G's screen,	
	"Let me see this for a second!"	
	• Drew a picture again and asked,	
	"What are you doing?"	

Feb. 3. 2008 (4:00–5:00 pm) Edu-Care classroom (Teacher A)

Child F	"Done! Like this?"	
	• Filled out a blank but mistakenly colored unintended to color on unwanted spots.	
	"Teacher! This is weird."	
	• Drew an earth. Green land and blue sea.	
Child C	"No! There should be any hole. Ok!"	
Child F	"This! This one! Do this like this!"	F out

Appendix B. Sample Questions of Children Interview

1. When you interacted with your friends, how was your feeling?
2. What did you newly gain after interacting with your friend? Is there any new information or new ideas that you learned from your friend?
3. When you were playing with your friends at the computer area, what things got in the way of expressing your ideas to other friends?
4. Please briefly describe what you did to help your friends create their own artifacts.

Appendix C. Sample Questions of Teacher Interview

1. How to scaffold children to interact each other at the computer area in this kindergarten classroom?
2. Please explain your teaching experience, how many years have you taught and where have you been a teacher?
3. Could you please explain the interaction patterns between children and peers, and teacher's interpretation about children's interaction at the computer areas?
4. Have you ever taken any college course that is related to computer technology in early childhood education?

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