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EXPLORING THE CREATIVE POSSIBILITY OF A HYBRID DESIGN THINKING WORKSHOP THROUGH FINDING SOLUTIONS FOR CHILDREN'S SAFETY IN THE CHILDCARE ENVIRONMENT

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Abstract. Design thinking process has two ways of on and off-line. In the online method, it facilitates communication more freely through the setting of anonymity, while the offline method allows participants to understand the comprehensive context of the workshop. This study investigates the creative possibility of a hybrid design thinking process through a workshop using "camera-off": anonymous setting, "camera-on": open setting, and instant visualization to find solutions for children's safety in the childcare environment. In the methodology, a qualitative method of three-dimensional interviews and observations were used to collect the active participants' opinions, and then the content analysis and the descriptive analysis were conducted. Three major childcare-related problems were noted during the workshop observations: 1) safety issues from children's physical activities; 2) teachers' excessive stress in childcare facilities, and 3) communication problems between parents and teachers. It was suggested that creative smart devices and artificial intelligence technologies could be helpful to relieve these problems. In insights of the hybrid design thinking workshop, the following points were noted: 1) active participants could freely share ideas in anonymous setting with "camera-off"; 2) active participants could understand various desires of diverse fields with "camera-on", and 3) active participants could understand find core problems and solutions through instant visualization. Hybrid design thinking is an creative method for understanding problems and finding solutions.

Keywords: childcare system, creative problem-solving, design thinking, education environment safety, hybrid design thinking.

Introduction

Creative design thinking is regarded as a useful tool for defining problems and finding effective solutions in complicated conditions with participants who have varying needs and interests (Brown, 2008; Martin, 2009; Cross, 2011; T. Kelley & D. Kelley, 2013; Menning

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et al., 2014; de Bono, 2015). It has two different modes of delivery: online and offline. Each style has *pros and cons*. In an offline setting, participants can easily understand ideas via the organization of thought with sticky notes and a whiteboard by themselves. As a weakness, participants can be concerned about the criticism, which hinders their ability to freely share ideas with random people. In an online setting, participants can freely share their ideas in an anonymous setting, but since they share their opinions via an online chat in *Zoom Video Communications* platform, it is harder for them to grasp the full content of shared ideas.

According to a social learning theory, the childcare environment is important for preschool children as a first stage of education (Bandura, 1979). It also claims that children's daycare facilities are important to develop children's behavior, because as the preschool children is learning by continuous interaction with the environment surrounded by them. Also, Cunningham (2008) and Timmons et al. (2007) revealed that a childcare center is an important place where learning takes place and builds cognitive, social, and emotional development in the early stages of the preschool child's life. These researches explain that creating of a better childcare environment ultimately helps children to receive a good quality education in a safe condition.

In South Korea (SK), safety accidents in childcare facilities are a major issue (Nam, 2020; Seong, 2021), and the number of parents who enroll their children in childcare facilities before elementary school is increasing rapidly (Choi & Kwon, 2015). The safety issues in childcare facilities refer to both physical and psychological problems that can affect children. Some accidents without direct physical harm can traumatize children like other physical injuries. Indeed, trauma can lead to emotional distress in children. Consequently, it is a serious issue to create safe childcare environments in which children's physical security and emotional stability in their educational setting are guaranteed.

Despite the urgency of the discussion, there have not been any changes in children's safety in educational facilities due to low awareness and the global COVID-19 pandemic (Shin et al., 2021). The opinions of various stakeholders, policymakers, teachers, parents, and technology developers should be considered in these changes. We intend to investigate solutions for problems of the children's safety in childcare system in SK through a hybrid design thinking workshop. The field of childcare has complicated conditions, which include the many unrevealed needs and interests of different stakeholders.

This paper examines the possibilities of the hybrid design thinking process by using the strengths of both online and offline design thinking workshops. In this workshop, conditions of anonymity and instant visualization were used. The 21 active participants and the 17 audiences in the online setting and the 8 facilitators in an online/offline arrangement took part. For more accurate data analysis, only the active participants participated in sharing ideas.

Through this workshop, this paper explores the effectiveness of the hybrid design thinking workshop. The research questions (RQs) are as follows:

- RQ 1: Is the hybrid design thinking workshop more effective for understanding problems and finding solutions than traditional problem solving techniques?
- RQ 2: What are the strengths and weaknesses of the hybrid design thinking workshop?

The detail concepts of the traditional problem-solving approach, the hybrid design thinking approach, and strengths and weakness of the hybrid design thinking approach will be explained throughout the paper, especially in the discussion section.

1. Literature review

1.1. Children's safety issues and *status quo* of technology

As the numbers of child abuse accidents and child-related issues have increased, the improvement of safety in the childcare environment by using smart devices is an important topic in SK (Choi & Kwon, 2015). With the implementation of the revised Children's Care Act (Kim, 2015), the installation of security cameras in daycare centers has become mandatory (Kim, 2015). Legal and institutional acts, such as strengthening childcare teachers' qualifications, increasing the number of assistant teachers, improving parental participation, and ensuring daycare center evaluation certification, have been applied (Park, 2015).

On top of these solutions, the government tries to implement smart child care systems. The spectrum of smart child care systems is broad, ranging from smart phones to artificial intelligence (AI). For example, in Ansan, one of cities in SK, officials attempt to implement security cameras based on AI technology (Park, 2021). The security camera with AI function detects negative emotional expressions from the teachers, which may lead to child abuse. The detection of potential abuse will be reported to the facility's director. In this way, AI technology can prevent tragedies that can hurt children physically and psychologically (Park, 2021). Indeed, the introduction and development of healthcare services for children are important at times when the care and protection of caregivers and childcare teachers are needed (Geum et al., 2017).

Large domestic companies have also developed a service that can monitor accident videos in real time to build smart daycare centers called *U+Biz LTE Blackbox Kids Alimi* (Hwang, 2021; Lee, 2015). Studies related to Internet of things healthcare device development for children, the use of wearable devices, and digital twin platforms indicate that there is a movement to improve the childcare environment through highly developed technologies (Han et al., 2019).

Healthcare devices are helpful in various fields of childcare, including safety management, health, growth, parenting, and education. Both parents and teachers had a positive perception of these smart devices, stating that they should be actively used for emergency responses (Kwon, 2019). It is necessary to create a smart childcare environment through the introduction of smart devices, because it is hard for teachers to fully control all safety accidents occurring in daycare centers (Kim & Auh, 2018). However, the establishment of a smart childcare environment using smart devices is still in the early stages of technological development. Ongoing talks are required for further improvement in children's safety in the facilities. In this study, we focus on identifying the issues and coming up with solutions to create a safe childcare environment.

1.2. Design thinking process

The design thinking process has proven to be a solid approach for engaging in complex and ill-defined problem scenarios (Brown, 2008; Martin, 2009; Cross, 2011; T. Kelley & D. Kelley, 2013; Menning et al., 2014; de Bono, 2015). Design thinking creates an effective setting for multidisciplinary and creative discussions, and an iterative thinking process. Through

convergence and divergence, participants explore problems and solutions in an ongoing conversation with others (Cross, 2011).

Rather than being limited to the design field, design thinking uses a five-step process of empathizing, defining, ideating, prototyping, and testing for problems that appear in each specialized field (Martin, 2009; Yang et al., 2015). This is also known as a problem-solving-driven method that reaches solutions through the process of convergence and divergence of cooperative thinking among participants (Cross, 2011). It refers to the ability to accurately understand a problem and evaluate an appropriate solution by synthesizing various related factors (Kim, 2002). The convergent and divergent thinking process objectively analyzes a given problem and suggests innovative solutions (Lee, 2009).

Thus, it is crucial to reflect on the diverse opinions of various participants, such as policymakers, childcare directors, teachers, parents, developmental psychologists, and pediatricians, to identify specific problems and find practical alternatives (Jang et al., 2017). Since the discrepancy between policy proposals and practical needs and applicability can cause ineffectiveness in guaranteeing children's physical safety and psychological stability in their educational environment (Jang et al., 2017; Yang, 2009), the hybrid design thinking process seems an appropriate method to use.

The original design thinking process has online and offline alternatives, which are both used in the field of service design, including public service and safety, social problem solving, smart life, service innovation, planning, and design innovation (Yoo, 2020). Each style has its own pros and cons. In an offline setting, participants can be hesitant to easily express their thoughts in front of random people due to the fear of criticism. Nevertheless, by directly organizing ideas, they can easily understand entire concepts and process. In the online setting, participants have difficulty grasping the full content of shared opinions because the communication is held on an online platform. However, they can more freely share their opinions in an anonymous setting.

By considering these features of current issues in childcare-related topics, as well as the COVID-19 pandemic crisis, the hybrid design thinking method is suggested as an alternative format for online design thinking workshops that uses the advantages of both online and offline settings. This led us to hypothesize that a hybrid type of design thinking could allow us to maximize the effectiveness of design thinking workshops.

2. The hybrid design thinking workshop

With an increase in the use of electronic devices, the number of online meetings also tends to increase. This has become highly prevalent during the COVID-19 pandemic (Donaldson et al., 2021; Thakur et al., 2021). In this context, the workshop held in this study was designed to explore problems and solutions for children's safety in the childcare environment. The questions for the hybrid design thinking workshop are as follows: What are the perceptions of teachers and parents towards dangerous situations and accidents that occur in childcare environments? What are the solutions that will enhance the childcare system?

Unlike the traditional design thinking process, the hybrid design thinking workshop utilizes methods that combine traditional online meeting methods of "camera-on" and newly

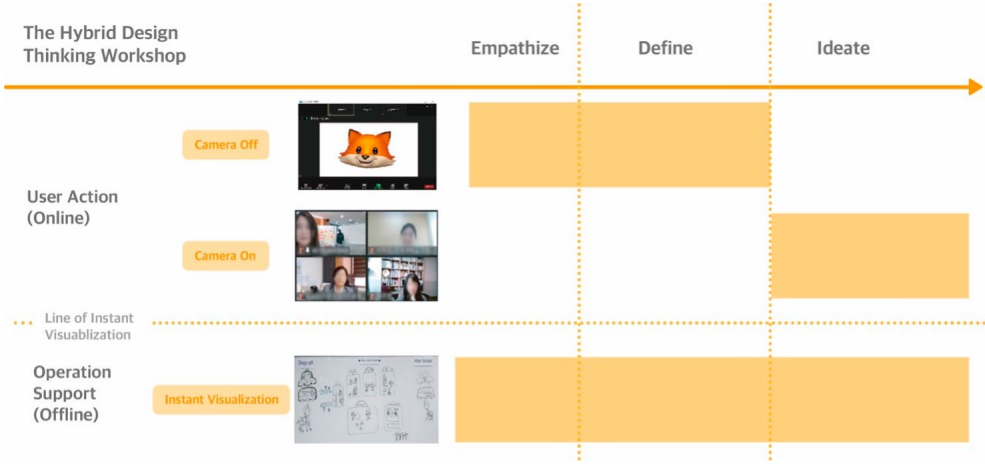

Figure 1. The hybrid design thinking workshop definition (source: created by authors)

suggested approaches of "camera-off" and adding a supplementary visualization tool from an offline setting for smooth running of the workshop "camera-on" refers to the status when the active participants turn on the *Zoom Video Communications* camera to fully reveal their identity as well as their facial expressions to others. On the other hand, "camera-off" implies the moment when the active participant turns off their *Zoom Video Communications* camera to hide their identity by participating with anonymity and a pseudonym.

The function of the camera altered depends on the stages of the workshop; for the "empathize" and "define" stages, cameras were turned off, creating an anonymous setting, and cameras were turned on in the "ideate" stage (Figure 1). The instant visualization continued for the entire workshop.

3. The hybrid thinking workshop process

In preparation of hybrid thinking workshop, seven sub-facilitators drew a goal-setting map and stakeholder map (Figure 2), which is used to identify the goal of the workshop and to find out direct related and non-related people to childcare center. In a goal-setting map, questions of "five whys and hows", were asked to derive the thoughts about a current status of childcare facilities. Through these process, it was possible to find out the main purpose of the workshop, which is helpful to solve the problem of childcare facilities. With the stakeholder map, it was possible to find which people were needed to discuss the problems and suggest ideas of solutions for a children's safety in educational environment. The goal-setting map not only assisted the facilitators to grasp the children's safety issues but also other problems and the background information of childcare environments. The stakeholder map functioned as a criterion to collect the samples for the research. Since the topic of the workshop was exclusive to the field of childcare, the researchers decided to focus on the direct associators in order to collect more relevant ideas for the agenda.

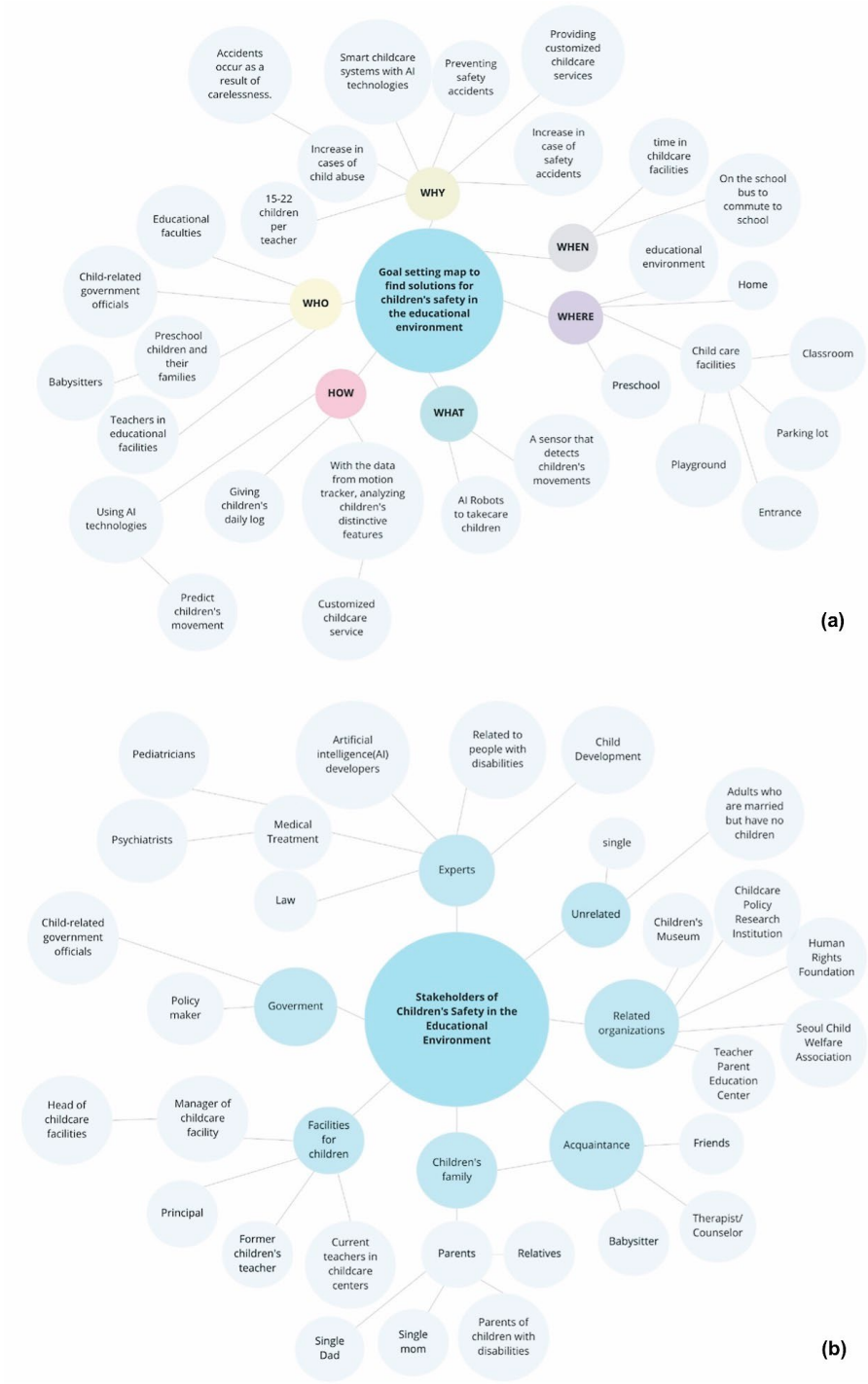

Figure 2. The workshop preparation: goal-setting (a) and stakeholder (b) maps (source: created by authors)

The workshop lasted three hours in the form of a hybrid meeting. The time was distributed into 30 minutes of introduction about the design thinking method, 30 minutes of the empathize stage, 30 minutes of the define stage, 60 minutes of stakeholders' self-introduction, and 30 minutes of the ideate stage. Since the goal of this workshop was to suggest possible solutions for child safety in the educational setting, it focused on the first three stages from the five stages of the design thinking process: empathize, define, ideate, prototype, and test. In this way, the active participants in the workshop could comprehend the problems and recommend possible solutions. Depending on the stages, the status of the camera ("camera-on" *versus* "camera-off") and the visualization tool for each stage are shown in Figure 3. When the active participants turned off their cameras, they used animal avatars so that even if everyone turned off their cameras, the atmosphere remained active and fun. A light mood in the workshop allowed the active participants to maintain focus throughout the long duration and adjust to the uncomfortable setting.

The activities of the active participants and facilitators in each phase followed a predetermined structure:

1. Empathize: the "camera-off" and "rename" functions of the video conferencing platform (*Zoom Video Communications*) were used so that all the active participants could identify problems in an anonymous setting. They expressed their concerns and viewed the problems from various perspectives. It was designed to allow anonymity so that the active participants could express their opinions freely. The active participants shared their opinions through a *Zoom Video Communications* chat, and two sub-facilitators collected them in a shared document (*Google Docs*). The other five sub-facilitators visualized the collected data using sticky notes on an offline whiteboard;

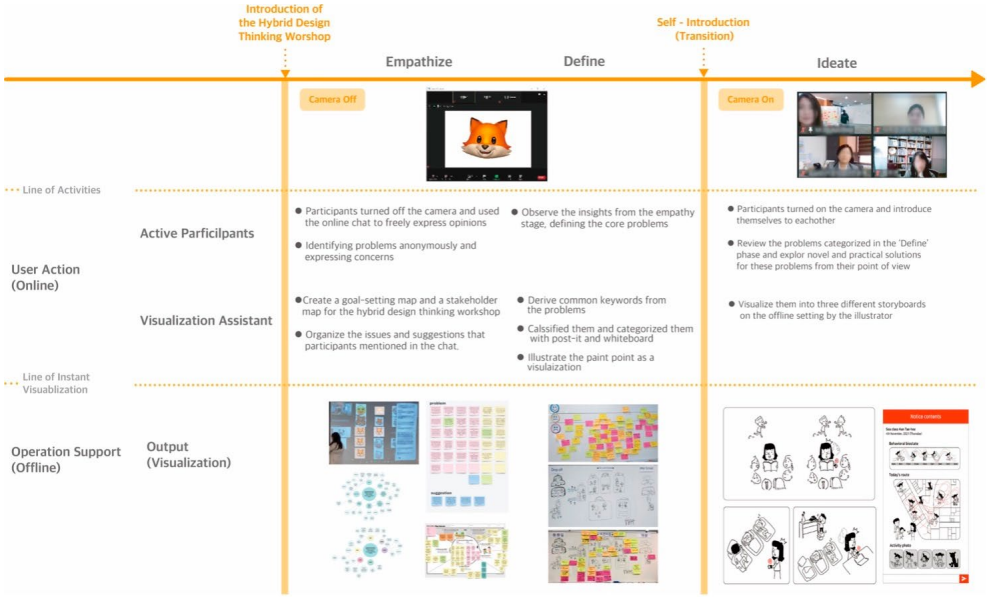

Figure 3. Overall process of the hybrid design thinking workshop (source: created by authors)

2. Define: five sub-facilitators derived common keywords from the problems visualized in the empathize phase, classified them, and categorized them using sticky notes and whiteboards. Illustrators drew a storyboard of a timeline in a childcare center. Based on these drawings, the active participants could understand general problems that could happen. The other facilitators reorganized the sticky notes to reemphasize the core problems in a certain time or space. This offline process was transmitted in real time to the video conferencing platform through the camera, allowing the active participants to observe insights from the first stage;
3. Ideate: the active participants who took place anonymously revealed their specialty, face, and name at this phase. By showing their identities, the active participants could share ideas from the views of their perspectives. They then reviewed the problems categorized in the define phase and explored novel and practical solutions to these problems. Two sub-facilitators collected these solutions and organized them using sticky notes and whiteboards. The illustrator chose three specific accidents in a childcare center to draw storyboards on how the active participants' solutions were applicable in a real setting. This offline process was also transmitted in real time.

4. Anonymous setting and instant visualization

All the active participants joined the *Zoom Video Communications* meeting, while the facilitators gathered in the offline setting to ensure the smooth running of the workshop. They provided instant visualization in real time, while the active participants shared their ideas through the online platform. Instant visualization refers to the organization of the active participants' ideas in the online platform using sticky notes and whiteboards in the offline setting (Figure 3). The entire process of instant visualization was held in an offline setting, and then promptly delivered to the active participants and audience through the *Zoom Video Communications* platform.

At the stages of empathize and define, the anonymous setting was used, and afterwards, participants revealed their identities for the remaining discussions (Figure 3). By turning on their cameras at the ideate stage, the active participants shared their opinions from the perspectives of their diverse professions and backgrounds.

5. Participants

The total number of participants is 46. But, the participants of this workshop were divided into three groups as follows (Table 1): 1) facilitators (the researchers); 2) active participants (sample group), and 3) audiences. Each group had a different role.

The people in first group were the researchers of this study as well as the facilitators. There were one main facilitator and seven sub-facilitators to support the second group to easily participate and understand the workshop.

Second group was the samples of the research. The study samples were selected based on the stakeholder map (Figure 2) that created by the researchers. In the stakeholder map, both direct and indirect stakeholders of children's safety in the educational environment

were included. The final sample comprised 21 direct stakeholders who are currently associated with the children aged three to five. They are from seven diversified fields as follows: 1) parents; 2) teachers in childcare facilities; 3) educational faculties; 4) child-related government officials/administrators; 5) AI developers; 6) pediatrician; 7) psychologist for children with disabilities. Their role was to freely share their opinions according to the given agenda (Table 1).

Lastly, there were 17 audiences who are the university students, majoring in design, childcare, and family studies. The role of audiences was auditing the workshop without any participation.

Table 1. Multidisciplinary participants (source: created by authors)

Role	Information of participants	Number of participant(s)	On/Offline
Main facilitator	Design thinking workshop professional facilitator	1	On and offline
Sub-facilitators	Assistants for visualization (illustrator and designer)	5	
		2	Online
Active participants (stakeholders)	Parents with the children aged 3–5	4	
	Teachers in childcare facilities	6	
	Educational faculties	2	
	Child-related government officials/ administrators	5	
	Artificial intelligence developers	2	
	Pediatrician	1	
	Psychologist for children with disabilities	1	
Audience members	University students from design, childcare, and family study majors	17	
Total		46	Both online and offline

6. Research methods

Before the workshop began, the researchers obtained consent for data collection by fully informing the active participant that the workshop data and personal information would be used solely for research purposes. But, their name, age, personal contacts, and gender would be concealed for their privacy. Out of 46 total participants of workshop, only 21 stakeholders were the active participants who shared their opinions according to the agenda. The researchers directly observed the active participants by collecting their comments on message chat of the *Zoom Video Communications* platform. Their comments were collected in *Google* document and analyzed using in-depth qualitative analysis of comments transcripts. Furthermore, the three-dimensional interviews were conducted to find the active participants' personal thoughts about the functions of the hybrid design thinking process. We asked questions related to effects of anonymity, multidisciplinary setting, instant visualization.

The purpose of this study was to look into the effectiveness of the hybrid design thinking workshop as a problem-solving strategy. Hence, in the analysis stage, we focused on analyzing the transcription of the workshop. The content analysis method was used to investigate the common issues and problems from the transcripts of their opinions. The researchers first read the transcripts before coding, rereading, comparing, and contrasting, recoding, and so on in an iterative analysis process. The details can be found in the findings section. The descriptive statistics method was used to subjectively analyze whether the active participants' anonymity affected their participation. The researchers found the number of words from each of their written comments and then calculated the number of words into the speaking time. The details of the descriptive table (Table 3) and holistic comparison of each group's means of speaking time (Figure 4) are explained under the analysis section.

7. Findings

The 21 active participants in the hybrid design thinking workshop shared 73 ideas related to childcare safety problems, and 38 ideas related to solutions. The content analysis aimed to identify common problems and solutions from different professional areas and perspectives (Table 2). The problems could be organized into three main categories: "Children's safety accidents during physical activities", "Excessive stress of teachers in childcare facilities", and "Communication problems between teachers and parents".

Table 2. Content analysis of ideas from the active participants (source: created by authors)

Meaning units	Code	Category	Theme
"There was a time when my child fell on a slide or stairs, or the floor of the playground was artificial grass, so my child got scratched or burned on a cold or hot day <…>. I think tracking children's movement with technical devices can prevent the accidents of falling".	Accidents when children fall down	Falling	Children's safety issues that occur during physical activities
"Many children get injured by bumping into each other, especially when they leave and enter the doors of facilities. <…> It would be great if there was an AI robot to notice the danger to children and teachers! So the accidents can be prevented".	Accidents when children bump into each other	Bumping	
"During nap time, children sometimes fall asleep in the wrong position and can't breathe while sleeping. <…> Smart technology devices to detect children's breathing is necessary to avoid unfortunate accidents".	The accident of suffocation when children are taking naps	Suffocating	

End of Table 2

Meaning units	Code	Category	Theme
"Because the number of teachers is smaller than the number of children, it is difficult to properly cope with safety problems. <…> We (teachers) need the smart devices to track children's movement, which can inform us to prevent accidents <…>. With this help, we can take care of all children".	Due to a lack of teachers, there are too many tasks to take care of	Excessive workload	Excessive stress of teachers in childcare facilities
"Teachers in facilities feel a heavy emotional burden from their work, which may negatively impact children".	Teachers have an emotional burden in terms of their tasks	Emotional burden	
"Coordinating opinions between parents and teachers is necessary to discuss whether it is absolutely impossible to get hurt, whether there are certain boundaries to understand the accidents, *etc.* Since the criteria from parents' views and teachers' views are different, it has to be coordinated together".	Coordination of opinions is needed between parents and teachers	Lack of communication	Communication problems between teachers and parents
"There were cases where an incident occurred when an unrecognized person came to pick up a child, and I had not received any notice or updated call from the parents. Also, sometimes we both (parents and teachers) miss updated news if we communicate through personal messengers. So, we need a separate smart device or application for better communication".	Updated information should be followed up between teachers and parents	Miscommunication	

8. Children's safety issues during physical activity

The three major causes of children's safety accidents were identified as physical damages from falling, bumping, and suffocating. Many children get injured falling from structures (*e.g.*, slides, staircases, slippery floors) that they use, interact with, and encounter in everyday life. Many expressed that these injuries happened when children bumped into each other while playing, were running in the same direction, and were packed together in one space. Finally, suffocating accidents can occur when children take naps at childcare facilities. Due to the unexpected nature of all these accidents, it is nearly impossible to prevent all accidents in advance. Thus, the many active participants expressed the need for AI technologies to track children's movements and to notice the dangers ahead as a solution.

9. Excessive stress of teachers in childcare facilities

The second theme is related to the excessive stress of teachers in childcare facilities, which can harm children indirectly. In this theme, the heavy workload and emotional burden of teachers were identified. First, it is difficult to focus on childcare due to excessive work, and the number of teachers is small compared to the number of children, making it difficult to take care of all of them and deal with safety accidents. Second, there is an emotional burden. The emotional burden caused by the workload, according to the teachers, is significant, implying that it can unintentionally express negative emotions to children. This can hurt children psychologically. For this reason, they expressed the need for a system or alternative that can reduce the cognitive and emotional burden of using smart childcare technologies. The suggested technologies were AI motion trackers and wearable devices. These can predict and prevent potential accidents. Therefore, the implementation of AI motion trackers for children and wearable devices for teachers can be a solution to reduce excessive stress at work.

10. Communication problems between parents and teachers

Lastly, the children's safety problems stemmed from the miscommunication between parents and teachers. In fact, it was found that there was a lack of communication between parents and teachers, and that there were communication errors. The lack of communication indicated a need to coordinate opinions. One example is the coordination of opinions on safety. It is necessary to discuss the possibility of getting hurt in certain circumstances and whether an accident is understandable. The active participants said that the parent's point of view and the teacher's point of view are usually different and should be coordinated together.

Miscommunication between teachers and parents regarding interaction-related problems were also discussed in the workshop. The active participants expressed the need for the immediacy of updated information for effective two-way communication between teachers and parents. For example, a lack of proper follow-up of information, such as a child's commuting time, incidents at daycare, special requests, and keep-in-mind notices, can seem minor but quickly escalate into a larger problem. Indeed, a tragedy of kidnappings occurred during the school as well due to miscommunication.

In addition, miscommunication can result in an emotional burden for teachers, confusion about shared information, and distrust between parents and teachers. With the use of personal messenger or communication tools, both parents and teachers can easily miss out on updated information, so they expressed the need for a separate application to communicate to resolve these errors. The development of an application to track a child's day and provide a platform for better communication between parents and teachers could be a solution to resolve these problem.

11. Analysis

11.1. Encouraging active participants' opinions in an anonymous setting

The first strength of the hybrid workshop was that it could provide an anonymous setting for the active participants to freely share ideas by turning off their cameras on the *Zoom Video*

Communications platform. Since it was a combination of a traditional method of online meeting with a "camera-on" and a newly suggested anonymous setting with the "camera-off", we could take advantage of all the benefits of online workshops. One of the teachers said, "I could freely share my ideas and express my opinion under the setting of anonymity by changing my profile photo and name into something else", which indicates that some of the active participants were concerned about others when giving their own opinions.

In addition, the researchers analyzed the collected transcripts of the active participants' opinions in order to understand the impact of anonymity more explicitly. A descriptive approach was used as a quantitative analysis method. The descriptive table (Table 3) included "the number of comments", "the number of words from the comments", and "the speaking time (minutes)". For speaking time, the researchers utilize the tool called "convert words to time" (Wordstotime.com, 2022). This tool provides the approximation of reading times (minutes) based on the average reading speed (130 words per minute) of the number of words.

Table 3. Summary of descriptive data on participation depending on camera status ("camera-off" *versus* "camera-on") (source: created by authors)

GROUP	PSEUDONYM	NUMBER OF COMMENTS		NUMBER OF WORDS		SPEAKING TIME (MINUTES)	
		Camera-off	Camera-on	Camera-off	Camera-on	Camera-off	Camera-on
Parents with the children aged 3–5	A	4	1	155	91	1.2	0.7
	B	1	1	43	25	0.3	0.2
	C	1	2	30	34	0.2	0.3
	D	7	3	188	63	1.4	0.5
Teachers in childcare facilities	E	12	4	299	146	2.3	1.1
	F	3	2	56	40	0.4	0.3
	G	1	1	38	21	0.3	0.2
	H	5	2	153	133	1.2	1
	I	1	2	151	76	1.2	0.6
	J	2	1	61	55	0.5	0.4
Educational faculties	K	1	3	64	91	0.5	0.7
	L	10	2	297	37	2.3	0.3
Child-related government officials / administrators	M	3	1	50	23	0.4	0.2
	N	2	1	39	19	0.3	0.1
	O	9	1	260	31	2	0.2
	P	2	4	24	43	0.2	0.3
	Q	2	1	86	123	0.7	0.9
Artificial intelligence developers	R	2	3	104	44	0.8	0.3
	S	1	1	33	26	0.3	0.2
Pediatrician	T	2	1	54	58	0.4	0.4

End of Table 3

GROUP	PSEUD-ONYM	NUMBER OF COMMENTS		NUMBER OF WORDS		SPEAKING TIME (MINUTES)	
		Camera-off	Camera-on	Camera-off	Camera-on	Camera-off	Camera-on
Psychologist for children with disabilities	U	2	1	39	17	0.3	0.1
Total		73	38	2224	1196	17.2	9
Mean		3.48	1.81	105.90	56.95	0.82	0.43
Standard deviation		3.27	1.03	89.09	39.06	0.69	0.29

In a comparison of the data under the section of "number of words", out of 21 stakeholders, 16 individuals wrote more words when they were sharing the problems with the "camera-off" venue (Table 3). In fact, over 76% of stakeholders shared their thoughts more actively in an anonymous environment. The mean and standard deviation of the anonymous setting doubled when the camera was off.

Furthermore, the researchers also compared the means of speaking time in each group for a more accurate comparison (Figure 4). Except for pediatricians, most of the other six

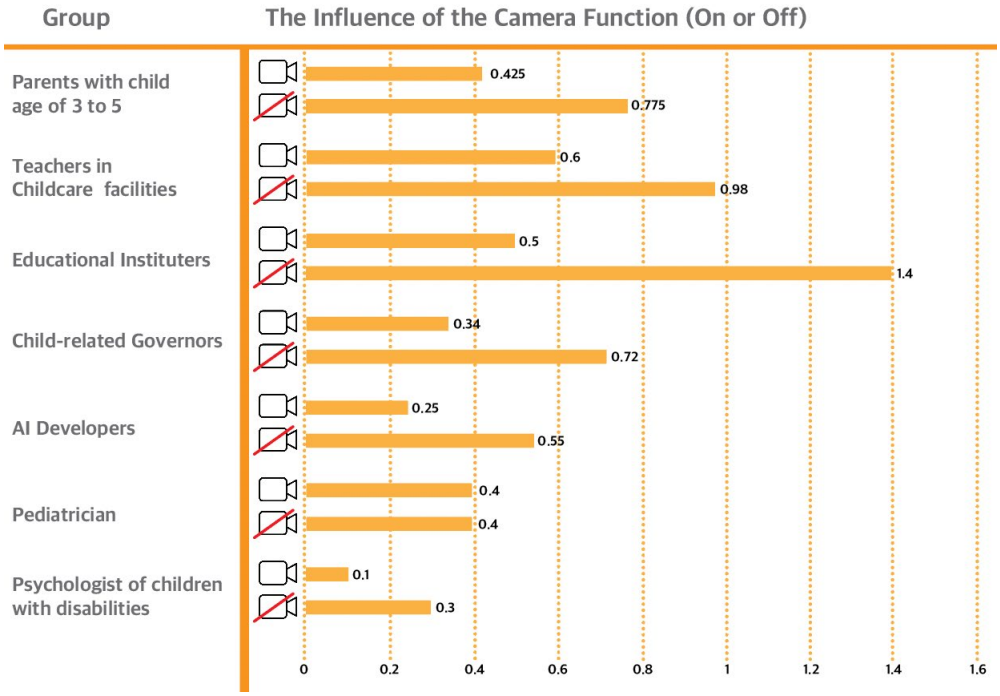

Figure 4. The mean of speaking time of each group depends on camera status ("camera-off" *versus* "camera-on") (source: created by authors)

groups displayed that the anonymity setting provided a more comfortable environment to share one's inner

thoughts. Interestingly, the active participants in the educational faculties group showed the biggest mean difference depending on the camera status. Pediatricians, on the other hand, demonstrated the smallest mean difference in camera status.

In conclusion, the majority of stakeholders are concerned about other groups of professions when the camera is on. Thus, it is possible to understand that they talked more comfortably and actively in an anonymous setting.

11.2. The necessity of development in childcare centers

The second strength of the hybrid design thinking workshop related to the necessity of developing various aspects of childcare centers through convergence and divergence of ideas. This workshop draws on a social discourse through a multidisciplinary environment to discuss problems and solutions from the various perspectives of different professionals. By sharing the ideas from diverse perspectives, the active participants from different professional backgrounds could have a broad understanding of different areas of study. One professional in child disability psychology said, "It was such an interesting workshop! I was able to see various perspectives and opinions that I hadn't thought of from my point of view". After understanding multiple perspectives in a deeper way using nonlinear methods, they could understand the necessity of development in certain areas. One of the parents thought it was necessary to consider emotional aspects along with physical accidents: "I only thought about the physical aspects of safety in a daycare center, but I found that I needed to think about the emotional aspects of children, as well as teachers' emotional burdens".

Through this workshop, we were able to understand the technology being studied and identify AI technology, an area that needs to be further developed. One of the AI technology developers stated, "I found that AI technology should develop its functions to have impact, not only to prevent accidents through AI motion trackers, but also to provide an advanced function for children's education". Consequently, the hybrid design thinking workshop was an effective tool for understanding development in certain fields by amplifying empathy among the active participants from multidisciplinary backgrounds.

11.3. The importance of instant visualization

The third strength of the workshop was the instant visualization of ideas. When the active participants shared their ideas only in the online chat, as a supplementary tool, assistants organized their ideas into sticky notes and the illustrator drew scenario pictures to show the a day timeline and spaces of childcare facilities. One of them said, "It was nice to see the instant visualization of our ideas through the drawings by the sub-facilitators offline because I could straightforwardly find the possible problems from the drawings on the whiteboard". Instant visualization by the sub-facilitators in offline helps all the active participants to find out the problems through the drawings on whiteboard.

Potential problems in childcare facilities could be divided into three categories: time, space and role. At first, time's problem can be happened when parents are dropping their

children off (Figure 5, image a). Supposed that commuting cars and children flocked into the gate at a same time, safety accidents can be caused. At second, space's problem can be happened in playgrounds where they are in physical activities. Also, in parking lots, car accidents can be occurred. At third, role's problem is related to limited number of teachers. When teachers are not available to take care of all the children in safe, children can be open

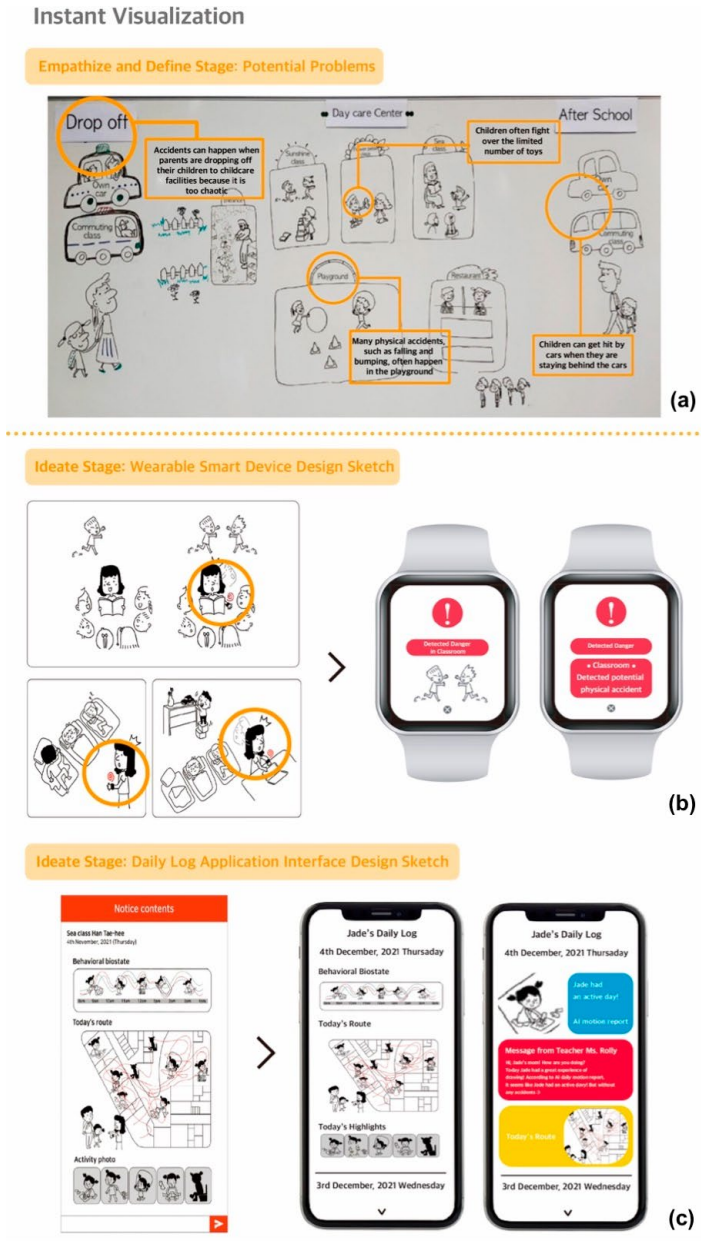

Figure 5. Instant visualization: potential problems related to childcare facilities (a), wearable smart device design sketch (b), and daily log application interface design sketch (c)
(source: created by authors)

to dangerous conditions. These possible occasions, based on the children's daily schedule, were displayed with instant visualization for the active participants. With the image for empathize and define stage (Figure 5, image a), all of the active participants could comprehend that the major problems in childcare facilities are related to three major themes: time, space, and roles. Before moving on to the ideation stage for solutions, they could ensure that they are on the same page about the problems.

At the ideate stage, the illustrator suggested three storyboards related to the ideas of solutions from the active participants. Storyboards explain how the technology can work as a solution to potential problems in childcare facilities. Based on these, sub-facilitators suggested wearable smart device design sketches and daily log application interface design sketches. One of the active participants said that "I could quickly understand how technology can help teachers to prevent possible accidents, and that can help parents and teachers to have better communication". For more details, the wearable smart device sketches showed that wearable devices alert teachers to prevent potential accidents (Figure 5, image b). The motion trackers in the classroom will detect any possible accidents and send an alert to the teachers' wearable devices. The emergency alert includes details about possible accidents: a livestream image, a place, and a description of danger. Based on the alert, teachers can react to the accidents immediately. The daily log application suggests a way to have better communication between parents and teachers by sharing the same information about children's days. This delivers information about the children's activities and general comments from the homeroom teacher (Figure 5, image c).

With this daily logging system, both teachers and children can understand each other's days based on the same information. This app would help them avoid misunderstandings and facilitate their communication. Without the illustrator, the active participants would not be able to imagine how the suggested solutions would look. Each individual would have had a different concept for applying the shared suggestions for solutions to smart devices. As a comprehensive organization, the instant visualization tool encouraged the active participants to understand how their ideas could be applicable to smart devices (Figure 5, images b–c). It is an effective way to deliver the holistic idea to all of the active participants.

Discussion

The primary purpose of this study is to explore the effectiveness of the hybrid design thinking method as a problem-solving approach. Since the main focus point was to explore the current problems and find possible scenarios of solutions, the researchers intentionally conducted only first three stages of traditional design thinking workshop: "empathize", "define", and "ideate".

The traditional problem-solving approach is based on the waterfall model. The waterfall model divides a project into a more ordered and systematic sequence (Balaji & Murugaiyan, 2012; Meinel et al., 2020). With this waterfall model feature, traditional problem-solving techniques follow a predetermined sequence based on obtaining a specified result (Balaji & Murugaiyan, 2012). This process entails analyzing current issues and proposing solutions (Meinel et al., 2020). It accomplishes the process by utilizing analysis, judgment, and

the knowledge of specialists. In general, this strategy concentrates on providing "how" and "what" answers to the needs of the developing the right products or services.

On the other hand, the design thinking method is a distinctive problem-solving technique. This approach is more circular and iterative, which indicates that it is more flexible and collaborative (Brown, 2008; Martin, 2009). It begins with observation of people and their cultural backgrounds to understand customers, then defines issues before diving into the specific challenges. In contrast to conventional techniques, it concentrated on providing more "why" answers related to user needs (Cross, 2011). In order to design a user-friendly experience, iterative prototyping, divergent thinking, and empathetic user research are all used in the design thinking approach.

The most appropriate approach for this study was design thinking because issues with children's safety in childcare facilities mostly involve human interactions with other people, objects, and environments. By recommending the hybrid design thinking approach, the study is looking to maximize the benefits of the design thinking methodology. This study also investigated the hybrid design thinking method's strengths and weaknesses by conducting a workshop in which children's safety in the childcare environment was addressed.

The hybrid design thinking workshop has the following advantages: 1) the hybrid environment promoted idea sharing by providing an anonymous venue; 2) the hybrid environment enabled stakeholders with a variety of backgrounds grasp various fields, and 3) rapid visualization enhances workshop comprehension.

The hybrid design thinking workshop allowed the active participants to conceal their identity by using the "camera-off" anonymity setting. According to the studies of communication and democracy, an atmosphere of anonymity supports the free expression of ideas and the tendency to express opinions on controversial concepts (Scott, 2004). Without fear of criticism, the active participants felt at ease expressing their opinions. The anonymity allowed them to concentrate solely on the comments' actual content rather than on the backgrounds of individuals. When people are not afraid of being judged, they are more likely to propose novel and experimental ideas (Scott, 2004). In the end, these attributes of anonymity facilitate communication, even when discussing delicate topics like one's safety that directly affect one's life. Furthermore, Lecuna Aguerrevere et al. (2020) argued that anonymity environments provide people with positive constraints. Positive constraints act as catalysts for people to unleash their creativity rather than suppress it. In fact, the researchers were able to determine why the number of people sharing ideas for problems with the "camera-off" setting and solutions with the "camera-on" setting differed. As a result, the researchers could evaluate the anonymity setting to encourage the active participants to unveil their inner ideas.

The hybrid design thinking method assisted the stakeholders to discover the necessity of development in childcare center through the discussion based in a multidisciplinary setting. This strength could be derived from the hybrid technique that assisted the researchers in overcoming the limitation of scale in space. Since the online setting does not limit the number of people to accommodate, the researchers could invite 21 stakeholders as well as 17 students as audiences. As a result, because the hybrid design could operate without regard to physical location, multiple stakeholders were able to empathize with various professions and industries. Furthermore, we discovered new ways to provide an invaluable educational experience for the students who served as our audiences.

Instant visualization encouraged the active participants to be on the same page with the process for the whole time. The instant visualization refers to the organized data from the active participants' comments on the chat box, and the illustrators based on their ideas were also provided by the professional illustrator. The facilitators in an offline setting simultaneously collected the comments that were written on the *Zoom Video Communications* platform by the active participants. If the workshop were only done offline, it would be difficult to collect the data for instant visualization because the steps necessary to do so would distract the active participants from the workshop. The organized data and images by facilitators could be delivered to active participants without any interruption, which represents the strength of an online setting. Consequently, this tool can be the strength of the hybrid design thinking workshop for any topic. Even if the agenda of the workshop were changed, the strength of instant visualization in the hybrid design thinking method would help the active participants holistically understand and follow the progress of the workshop. By staying on the right track, the active participants would go through a more rich and fruitful thinking process. The deep thoughts within the agenda would increase the quality of the overall data from the workshop.

The weaknesses of the hybrid design thinking workshop can be found as follows: 1) the Internet connection has an impact on the workshop's quality; 2) the rate of involvement in communication can be impacted by digital literacy. If the internet connection is bad or slow, it will be hard for facilitators to assist the active participants and for later to engage actively in the workshop. The obstruction of the internet can cease the flow of communication by slowing down the process of the design thinking method. The term "digital literacy" describes a person's individual technological proficiency. We may say that someone has high digital literacy if they are able to use digital platforms to freely put their ideas into action. Depending on a person's circumstances, their level of digital literacy can vary. The degree of one's digital literacy can impact the rate of participation in communication. If one feels comfortable with digital devices, he or she will actively and easily participate in the hybrid workshop, and *vice versa*. Therefore, there may be discrepancies in the number of opinions as a result of these variations.

Considering these characteristics of the hybrid workshop, the applicable areas can be those that focus on idea derivation or problem identification. For example, this method can be useful for teams such as human–computer interaction, user experience, and marketing because these teams should sympathize with customers' experiences for the improvement of certain services or products. It can also be useful in the hospitality industry, which aims to provide the best services and experiences for people.

The proposed study has certain limitations. First, the number of stakeholders from seven different fields is not equally distributed. In fact, the number of the active participants in the group of parents, teachers, and child-related government officials was double that of the group of educational faculties, AI developers, pediatricians, and psychologists for children with disabilities. The unequal distribution of stakeholders could have influenced the number of words, which indicates the results might overrepresent the opinions of the former groups. Future research should aim to include an equal number of stakeholders from each profession. Second, the research's findings are based on the professions of those who are Korean

and located in SK. This helps to add to the distinctiveness of the research and has significant effects for the field of Korean childcare environments. Nevertheless, the research's findings may not be relevant in all cultural settings. Third, the level of digital literacy may have affected the participation rate. Although all stakeholders knew how to express their thoughts in online chat, people who are not accustomed to typing may not have expressed all of their thoughts, unlike those who are accustomed to typing.

The researchers were unable to determine the impacts of digital literacy in the hybrid design thinking workshop. As a result, the study that will be carried out in the future on this hybrid design thinking workshop within the context of children's safety issues in childcare settings will have the same topic and procedure but involve different stakeholders. The stakeholders would be divided into two groups: 1) the group with a similar level of digital literacy, and 2) the group with a dissimilar level of digital literacy. Thus, the researchers will primarily conduct the survey for future stakeholders in order to figure out the level of one's digital literacy skills. We will ask questions like, "How many times per week are you writing sentences on your laptop?". The research based on the comparison of two groups will demonstrate the effectiveness of digital literacy in the hybrid design thinking method.

Conclusions

The three-dimensional method of communication in the hybrid design thinking workshop which used "camera-off": anonymous setting and "camera-on": open setting helped the active participants think creatively. In the workshop, significant problems were found in the following areas: 1) accidents related to children's physical actions; 2) the excessive stress of teachers in childcare facilities, and 3) the interaction problems between parents and teachers. Solutions were suggested, such as wearable smart devices based on AI technology.

With these findings, a study could determine the effectiveness of hybrid design thinking as a problem-solving approach. To conduct this method, the following strengths and weaknesses of it were analyzed. The advantages are: 1) an anonymous setting was effective for encouraging the active participants to actively and freely participate in the workshop; 2) the active participants were able to identify with the need for advancement in each subject through the process of convergence and divergence of ideas from many perspectives, and 3) the active the participants could grasp core ideas and stay on the same page through the positive effects of instant visualization. The weaknesses are: 1) the quality of the workshop is shaped by the Internet connection, and 2) digital literacy may have an influence on the frequency of communication engagement.

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