Exploring Virtual Reality-based Teaching Capacities: Focusing on Survival Swimming during COVID-19

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Abstract. This study aims to analyse teaching capacities exhibited by survival swimming instructors applying virtual reality (VR) devices in the education field. We conducted in-depth interviews with swimming instructors to obtain research data, which was then qualitatively analysed. Based on the research results, the following capacities were derived. First, as the VR and simulator-based survival swimming classes utilise educational equipment, the ability to skilfully handle educational equipment is considered a vital teaching capacity. Second, strong communication skills are required to accurately explain the class objectives and contents. To achieve the class goals, teachers should practice using educational equipment before class, answer students' queries during and after practice, and prepare the necessary materials so that the class is well organised. Finally, the principal lecturer needs to be able to quickly improvise in various situations as needed to ensure students remain focused. Under the circumstances where survival swimming education was restricted due to the COVID-19 pandemic, the research results indicated that survival swimming education applying VR and simulation devices allowed students to indirectly gain experience, interest, and pleasure. Therefore, it is expected that VR-based education can increase students' interest and learning performance in survival swimming. Finally, VR-based teaching capacities were derived based on the research results.

Keywords: teaching capacity; virtual reality-based teaching; physical education; elementary education; survival swimming

1. Introduction
In South Korea, due to continuous drowning accidents, there is an increasing social consensus that learning survival swimming is necessary. The Korean government therefore recently revised the national curriculum to include survival

swimming education as part of water leisure safety and to facilitate mandatory implementation of survival swimming education (Ministry of Education, 2016). However, most schools avoid providing survival swimming education due to several limitations in their surrounding environments such as possible accidents and injuries, lack of swimming facilities, and transportation to get there (Jeon & Cho, 2007). Accordingly, although practical training should form the core of survival swimming education, teachers have had to utilise audio-visual materials due to teacher's insufficient swimming skills (Kwon & Jung, 2021). Moreover, since swimming pool operations have been repeatedly halted and resumed due to the COVID-19 pandemic, elementary schools have converted survival swimming education to theoretical education to protect elementary school students from exposure to the disease.

In response to these concerns, many people have expressed an increasing interest in methods for providing physical education based on virtual reality (VR) hardware and software to ensure the health and safety of students while also providing appropriate education (Cheng, 2021). VR is a human-computer interaction technology in which people use computer software to mimic real-world experiences. This technology and relevant simulations have practical applications in the education field to exert positive effects on learner motivation and increase learners' interest in and enjoyment of education (Bae et al. 2018; Elmqaddem, 2019; Kavanagh et al., 2017). These tools also allow users to experience situations that cannot be explored in the real world (Clark, 2006).

Given this perspective, this study analysed whether VR-based survival swimming education could create positive changes in the learning attitudes of students toward survival swimming, especially for students who fear water and are reluctant to participate in such classes. VR-based swimming education can also be applied as an alternative learning method to overcome the limitations of in-person survival swimming education owing to the spread of COVID-19. VR technology has been used mainly in physical education and safety experience education, and multiple studies on the application of this technology have been carried out in various fields (Araiza-Alba et al., 2021; Zhu & Kou, 2021; van Duijn et al., 2021). Thus, applying VR technology in an education setting was evaluated as an alternative method to increase the effectiveness of survival swimming education policies formulated by the Korean government (Park, 2020).

To teach VR-based survival swimming classes, teachers need to develop the necessary teaching capacities, which differ considerably from the skills required for practical training. In addition, the instructors might struggle to access VR-based survival swimming education reference. It may also be challenging for them to receive in-service training designed to increase their teaching capacities as such training programs have not yet been developed. Due to these issues, the instructors have constantly struggled to develop their own teaching methods and apply them directly and practically in classes, thus depending on trial and error to determine effective strategies.

Therefore, this study conducted in-depth interviews with a focus on survival swimming instructors who had been recognised by organisations, students, and other teachers (in terms of their teaching capacities) and who had expanded their teaching fields to include VR learning during the COVID-19 pandemic. This study

analysed their motivations for specialising in VR-based survival swimming education and examined their capacities including goals, targets, and methods employed to teach.

2. Theoretical Background
2.1. VR and experiential learning
It might appear that mutual circulation between the virtual world and the real world can be facilitated using a display. However, even though the virtual world can include objects from the real world, they are never identical. (Milgram & Colquhoun, 1999). In other words, virtual objects that are produced to mimic actual objects cannot exist as real objects and vice versa. VR refers to an artificial environment that effectively or essentially exists in the same or a similar way to the real world (Lee, 2004). VR enables people to perceive the same or a similar experience as they would in the real world. A VR experience can therefore be a direct experience of human beings despite ongoing discussions about the state of practical existence of VR from an ontological view.

Prior to the active development and spread of immersive VR technology, researchers performed several studies on experiential learning based on partial VR application. These studies reported that people considered VR experiences to be equal or similar to actual real-world experiences (Kamarainen et al., 2013; Klopfer et al., 2005; Perry, 2014; Squire & Klopfer, 2007). Dunleavy (2014) analysed previous studies on partial VR application and found that they adopted constructivism and situated learning theory, which focused on social interactions that play an important role in constructing knowledge (Cobb & Bowers, 1999), as theoretical grounds. Partial VR application provided similar situations to the actual environment and enabled users to form knowledge and meanings through their virtual experiences (Dunleavy, 2014). The latest VR technology, which has advanced in terms of lifelike interactions and vivid images, can provide users with similar experiences to real life based on a strong sense of presence beyond the simple VR experience of the past. Furthermore, users will more clearly recognise the VR experience provided by the most advanced VR technology as direct experience.

The existing experiential learning theory, which emphasized physical experience and action learning, described the predominance of dichotomous thinking based on direct and indirect experience obtained in the field and from media, respectively (Dewey, 1938:13-27; Kolb, 1984:20). However, in recent times, people find indirect experience obtained through media to be more vivid, realistic, and similar to direct experience due to the development of virtual environment technology, such as VR and augmented reality. For this reason, the difference between direct and indirect experience has been gradually obscured. In general, a sense of presence serves as a crucial element that enables people to consider indirect experience to be similar or equal to direct experience (Parong et al., 2020; Lackey et al., 2016; Servotte et al., 2020; Slater, 2018). A sense of presence refers to someone feeling like they are still in a real space when they are actually in a virtual environment without physical contact. It also indicates a perception of virtual objects in the real space as real objects. Factors affecting a sense of presence include interactions and vividness (Kim et al., 2021; Kim & Ko, 2019). Immersive VR technology has advanced based on interactions and audio-visual vividness as

head-mounted displays (HMD) have become popular. In addition, researchers have developed and commercialised methods that facilitate direct interactions with virtual objects or simulate their movement. It is therefore expected that future VR technology will enable users to more strongly perceive virtual experiences as direct experiences.

VR technology can offer learning opportunities for users in artificially created situations similar or equal to real situations by using visualisation and a sense of interaction with learning targets (Piovesan et al., 2012). Sacks et al. (2013) reported that a VR-based education method was more effective than existing education methods. Some of the potential advantages of VR application in education and training are as follows (Velev & Zlateva, 2017):

- Virtual platforms and headsets are the new tools for inspiring creative learning.
- Education that is not possible in reality, will be possible in VR.
- Virtual game-based experience increases students' motivation.
- Collaboration in the VR classroom fosters leaners' social integration.
- Learning is achieved by direct interaction, not by mouse clicks.
- The results from the learning process are truly assessed.

2.2. VR-based survival swimming

Several researchers have conducted research on survival swimming instructors. Kang et al. (2021) assessed social interest in the instructors and suggested a systematic approach to support them. Kwon et al. (2019) pointed out the lack of experienced survival swimming instructors. Lee and Kim (2020) investigated the core capacities of instructors who provided survival swimming education based on practical training and examined the elements and priorities of these core capacities. Kim et al. (2018) investigated qualitative improvement of educational contents on survival swimming rather than teaching capacities. Sun (2020) examined whether female teachers in elementary schools were aware of survival swimming. There have been few studies, however, that analyse the teaching capacities required for survival swimming instructors who provide VR-based survival swimming education, which is currently being implemented in the education field.

Park (2020) conducted an experiment where students who had previously gained experience through a physical learning session learnt survival swimming based on instant interactions, a characteristic of VR, in a VR-based survival swimming class. Students also learnt survival swimming in stages based on the active use and manipulation of controllers in virtual space instead of passive video watching. The experimental result indicated that students gained objective and successful experience perceived in the staged survival swimming learning processes. Accordingly, based on these students' objective experiences, VR-based survival swimming education increased students' awareness of risks related to water safety accidents in a VR environment that was similar or equal to real environment. Furthermore, experience-based education on preventing water safety incidents, which encouraged students to actively protect their own safety, positively influenced learners' perceptions of how to prevent water safety accidents (Park, 2020).

To expand the research scope of previous studies, this study analysed the motivation of survival swimming instructors who had recently added VR-based lessons to their previous experience as survival swimming teachers. This study also obtained information on how instructors specialising in VR-based survival swimming education survived competition against numerous other instructor applicants after they began working as survival swimming instructors applying VR devices. Furthermore, this study investigated the pedagogic capacities of survival swimming instructors who were applying VR devices to teach students and compared these capacities with those of existing instructors to intensively analyse how the differences in capacities affected students' learning.

3. Research Methods
The theoretical basis for the qualitative method is phenomenological research. It describes the experiential meaning of a concept or phenomenon that all research participants have in common while experiencing the phenomenon (Neubauer et al., 2019). For data collection, in-depth interviews were used to draw people's thoughts, knowledge, and perspectives in more depth. Lastly, thematic analysis was used to classify common themes among the collected data (Vaismoradi et al., 2013).

3.1. Research participants
To select research participants in qualitative research, researchers should prioritise whether the candidates can obtain sufficient appropriate data to meet the research objectives (Creswell, 1998). This study selected four research participants through the following process. First, we recruited candidates who had recently worked as survival swimming instructors in elementary schools located in different regions. As these experts had worked in swimming-related fields for several years, they were regarded as "professional swimming instructors." Among the candidates, four were selected whose capacities as instructors had been recognised by both peer instructors and students and who had put forth consistent efforts to improve their personal teaching capacities, including guiding students, developing and applying teaching contents and methods, and evaluating teaching performance. Moreover, the selected research participants possessed various types of swimming-related certificates. All participants had acquired a lifeguarding certificate. Finally, they are 20-30s females living in the metropolitan areas. Table 1, shown below, provides brief information on the research participants. Detailed information on these participants is described in the following sections.

Table 1. Personal characteristics of research participants and their personal information

Name (pseudonym)	Sex	Teaching experience (years)	Details
Hahn	Female	3	This instructor worked as a general swimming instructor and a survival swimming instructor in a swimming pool after her retirement as a professional fin swimmer.

Ham	Female	8	This instructor worked as a general swimming instructor and a survival swimming instructor for several years after her retirement as a professional fin swimmer.
Ahn	Female	6	This instructor gained experience in the field of water safety after beginning work as a lifeguard in her early 20s.
Byeon	Female	8	This instructor taught general swimming and survival swimming for several years based on her previous experience as a swimmer while she was a student.

3.2. Data collection

In-depth interviews were conducted with the participants. In these intensive interviews, participants provided responses to questions on their direct and practical experience as survival swimming instructors, awareness of problems, and methods for solving them. The selection process of participants in qualitative research should prioritise whether they can properly exchange their information with researchers (Lee, 2003). Thus, we selected four survival swimming instructors who were already acquainted with the researchers, had established a rapport with them, and satisfied research objectives and criteria as participants. The individuals were contacted directly, provided explanations about the research objectives and methods, after which they submitted their written agreement to participate in the study.

The entire interview contents were transcribed, and the transcription result was stored and managed as research data. Four individuals participated in this interview processes for a total of three or more times from October to November 2021. During this period, the researchers contacted participants 12 or more times. To carry out the full course of in-depth interviews with each participant, the researchers directly visited participants' workplaces. Each interview lasted approximately 50–90 minutes.

The feasibility of the data collection processes and procedures was reviewed by an expert group consisting of two employees of organisations related to survival swimming and three elementary school teachers. While conducting the feasibility analysis of data collection procedures from in-depth interviews, the expert group considered whether the interview contents reflected the purposes and objectives of this study and if there were any problems with the content. When certain interview data were found to be problematic (e.g., contents irrelevant to the research topic, involuntary participation, participants' identity exposure etc.) during this process, the researchers and the expert group discussed the exclusion of the data.

3.3. Data analysis

The data analysis procedure in qualitative research refers to the process of determining the order and significance of the data collected. Qualitative research is also a process of reducing the amount of data based on theme-based elements and verifying and correlating analytic categories to identify the themes and

significance (Dey, 1993). This study analysed the data collected from in-depth interviews based on inductive analysis (Patton, 2002).

During the transcription process, the participants agreed to have the interviews transcribed to prevent data loss. Interviews were recorded electronically, and the recorded data were coded and analysed. In the case that there were insufficient contents, additional interviews were conducted.

The data collected from each participant was coded by considering characteristics of the educational attempts they had made during their work as survival swimming instructors. The minimum unit newly derived in the coding process, was registered in a node. Accordingly, this study integrated similar words and removed duplicated words in the coding process. The researchers had multiple discussions to inspect words of the minimum unit that should be newly registered or integrated. The expert group formed for this study reviewed whether the initial extraction process and assumptions applied in the processes of adding and integrating words was adequate. Through these processes, research data were classified into four large areas and five medium areas. Table 2 describes the categorisation of the research data.

Table 2. Categorisation and conceptualisation results of the research data

Large areas	Medium areas	Small areas
Motivation for becoming a VR-based survival swimming instructor	Becoming a teacher	Acquisition of a teaching certificate, expansion of a range of teaching methods, and motivation for having newly become a VR-based survival swimming instructor
Operation of survival swimming classes	Advantages of applying VR and simulators in survival swimming classes	Differences between VR-based and general survival swimming classes
	Educational evaluation	Analysis of educational contents and methods for education evaluation
Work as a survival swimming instructor	Self-feedback on teaching in classes	Analysis of weaknesses and self-reflection
	Factors as an instructor	Necessary capacities as an instructor

3.4. Research Integrity
This study conducted a review (Kim, 1997; Guba, 1981; Nelson, 1990) to increase the research integrity by considering various characteristics of the research processes applied. Specifically, during the review process, participants,

researchers, and the expert group revisited discussions on whether the data collection process and data analysis result reflected the intended research purpose. Specifically, it examined whether the raw data collected had been accurately classified and analysed to evaluate the validity of the obtained data and analytic results and if the data had been analysed from different perspectives. In the first verification stage, the analytic results of the raw data were shown to participants to confirm the results. In the second verification stage, the expert group consisting was formed to review the analytical results.

To ensure research integrity and ethics, participants agreed to participate after being clearly informed about the research purposes and subsequent use of the research results. Participants were also assured that the interview contents would only be used for research purposes. The interview contents were recorded after considering the schedules of the individual research participants. They were also checked for errors related to the researchers' subjective judgments. Participants' privacy was protected by disguising their personal information and allowing them to use pseudonyms.

4. Results

The results indicated that the swimming instructors who participated in this study demonstrated sufficient teaching capacities to implement effective survival swimming education about educational goals and teaching and evaluation methods. Schools have recently begun to prefer to provide survival swimming education in indoor classes rather than swimming pools due to the COVID-19 pandemic. As a result, instructors who participated in this study had also held survival swimming classes using VR and simulation devices. For this reason, the capacity to handle various devices required for survival swimming education was evaluated as a significant competence of the instructor. Participants also used creative methods to teach students and implement an adjusted educational goal according to the newly revised curriculum. Moreover, they constantly reflected on their own teaching methods and attempted to improve them. These capacities of participants were recognised as significant for instructors based on their association with the establishment of educational goals, selection of educational contents and methods, and educational evaluation and feedback processes.

4.1. Motivation for having newly become a survival swimming instructor

If instructors in different types of sports, including survival swimming, begin playing a certain sport related to their interests, hobbies, or athletic career while they were students, they tend to continue to play the sport as adults. This makes them more likely to work as instructors in their chosen sport. According to an interview with Byeon, a participant survival swimming instructor, she developed her athletic career as a swimmer as a student and began working as a swimming instructor in a sport centre at the age of 20 based on her previous experience with and affection for children. As she began working as a swimming instructor without a university degree, she was concerned about her life. However, peer instructors supported her in adapting to the position of a swimming instructor and she was employed as a swimming instructor at the time of the interview.

> *I really like children, so I began working in a swimming pool for children*
> *when I was 20 years old. When I just worked as a swimming instructor, I*

> *did not know anything about this job, but other instructors in the swimming pool helped and taught me a lot. In fact, I was too young around that time… I thought, "I am going to start a new job now but is it right to work like this?" I just got this job at that time because I found it fun to teach someone else and a teaching job matched my personality well. The position of a swimming instructor has put a great amount of physical pressure on my body, but I find this job is suitable for me. That is why I have worked as a swimming instructor so far.* (Byeon)

Participant Ahn stated that she showed an extraordinary interest in water activities beginning in high school. Consequently, she wondered whether she should be a swimming instructor and a lifeguard as an adult. She was offered the position of swimming instructor by chance at a place that she visited to attend a training session on teaching swimming. She began working as a swimming instructor after accepting their offer and was able to constantly accumulate knowledge of teaching methods.

> *I really wanted to be a swimming instructor from when I was in high school. I worked as a lifeguard for a long time, but I kept thinking about whether I should change my job to be a swimming instructor. Then, one day, someone I knew told me about a place that provided a teacher training in swimming. I went to that place to take the training, and a person there suddenly asked me to swim. After watching me swimming, this person unexpectedly offered me the position of a swimming instructor. I had just come to take a training and I got offered to teach there. The place was a swimming pool in a hotel. At first, I studied teaching methods intensively for a week. I had also studied teaching methods a lot since high school. So, it was not a problem for me to instantly start working as an instructor.* (Ahn)

Most research participants responded that they had begun swimming based on their interest in it as students and that swimming experience naturally drove them to work as survival swimming instructors as adults. In general, they exhibited a high level of job satisfaction working as survival swimming instructors. Participants, who were in their late 20s on average, indicated that they began working as swimming instructors as soon as they retired as professional swimmers. They designed their career paths based on jobs in the fields of water activities from high school. As such, they considered that their tendencies and talents matched the necessary capacities of a swimming instructor.

4.2. Advantages of VR-based survival swimming classes

As instructors provide general survival swimming education in swimming pools, they should exert great efforts to manage students in every step of the way—from taking a shower to entering the water. According to Ham, VR-based survival swimming education has the advantage of reducing class preparation time because indoor education is possible. Moreover, survival swimming education based on VR experiences can create greater interest and more effective outcomes for students who fear the water compared to classes based on blackboards and theories.

> *It truly brings comfort for instructors. This type of education is so comfortable that it can be called a class for instructors. It is really*

uncomfortable to hold a survival swimming class wearing a swimsuit or a wetsuit. It is also stressful to let tens of students enter a swimming pool and watch them during a class. A swimming class performed in a swimming pool is turmoil. Should I take a shower with children in the shower room and take care of them at the same time? However, VR survival swimming education is performed in an indoor class and teaching contents for each class are established. I like this neat type of education. It is also advantageous that I can use both VR contents and various types of audio-visual materials to increase students' level of understanding. I find these theoretical contents necessary. Children who are not comfortable with the water might learn survival swimming more effectively by experiencing it based on VR contents in advance and later entering a swimming pool than by simply watching videos and learning contents written on a blackboard in a class. VR contents might increase the children's level of interest when they are provided such contents. (Ham)

Byeon stated that VR-based survival swimming education performed in an indoor class can alleviate instructors' fatigue because they can speak comfortably at a normal volume and use VR devices to deliver educational contents based on experience instead of physically delivering them. Moreover, students tend to focus on what the survival swimming instructor says more intensely in a VR-based survival swimming class than in a general swimming pool due to their curiosity about VR.

The advantage of this type of education is that we instructors can speak at a low volume. When I teach survival swimming for more than two or three hours per day, my throat hurts. However, a VR-based survival swimming class definitely provides comfort for instructors because students can learn survival swimming based on VR contents. Children also tend to be quiet and follow what I say so that they can experience VR contents more quickly… The atmosphere of a VR-based survival swimming class is more pleasant than that of a general survival swimming class." (Byeon)

According to an interview with Ahn, students used to have difficulty concentrating when they learnt cardiopulmonary resuscitation (CPR) in general survival swimming classes. However, when she taught CPR to students using simulators in a VR-based survival swimming class, students were able to monitor information on the number of compressions, number of effective compressions, number of compression failures, probability of revival, and depth of compression in real time. As simulation devices can increase students' interest in a topic, the need for the instructor to control students may also be minimised.

I used to conduct CPR classes using only animation contents, but students did not concentrate in these classes at all. On the contrary, when I teach CPR by using simulators, students focus on these classes very well. When I give them feedback, such as "press it more strongly" and "take your pose like this," they listen to my words carefully to increase the number of their effective compressions for CPR displayed on a monitor. I do not need to control external things outside of the class. (Ahn)

When instructors hold survival swimming classes in swimming pools, they must speak to students at a comparatively higher volume to deliver educational

contents. For this reason, instructors who teach survival swimming in swimming pools for a long time are likely to experience throat pain and eventually suffer from vocal fold nodules. In contrast, survival swimming classes based on VR and simulation devices can increase students' interest in the lesson as well as the quality of education. All participants agreed that VR-based survival swimming education effectively improved the perceptions of students who feared the water by allowing them to virtually experience survival swimming before entering an actual swimming pool. Moreover, CPR classes based on VR and simulation devices maximised educational effectiveness because these classes allowed learners to monitor their scores in real time. In this regard, VR-based CPR classes were evaluated to be more effective than general CPR classes where students were asked to simply use animated contents.

4.3. Educational evaluation

Ham discussed how she conducted educational evaluation based on VR experience in the form of quizzes after students finished learning. She controlled the level of quiz difficulty according to students' level of knowledge. At the end of her classes, she emphasised that students can practically apply survival swimming education contents that they have learnt based on VR experience to other water-related places such as swimming pools and beaches. She assessed that survival swimming education applying simulators had the advantage of increasing students' interest in the topic and the disadvantage of harming the nature of survival swimming classes (i.e., the possibility of the class focused on fun and interest rather than learning). To overcome this disadvantage, she reminded students about the order of CPR and precautions when performing chest compressions.

> *I let students undergo VR experience and solve quizzes. I show only questions and select multiple students to ask them to answer the questions and draw students' attention. Children are not familiar with survival swimming, so I evaluate their knowledge based on questions that are not extremely difficult. Then, at the end of the class, I highlight that they will guarantee their own safety and even save other people by recalling and applying what they have learnt in the class when they go to beaches or swimming pools in the future. I finish my class by emphasising that they can save other people by remembering only the order of CPR beyond the significance of finding the accurate location to do chest compressions.* (Ham)

Byeon also mentioned that she conducted educational evaluations based on quizzes after students underwent the VR experience. She said that she provided students detailed explanations about the quiz choices, specifically the reasons for both correct and incorrect answers. When students had a high percentage of correct answers for the quizzes, she allowed them to freely experience VR contents during a break time of approximately three to five minutes.

> *When students solve quizzes and ask, "what is underwater swimming?" I try to describe underwater swimming according to their level of knowledge and clearly explain why this choice is a correct or incorrect answer. Then I tell students that I will hold a VR class again when they solve quizzes successfully. I reckon that quizzes are important. When*

> *children follow my instructions well, I allow them to freely experience VR contents for about three to five minutes."* (Byeon)

Students independently participate in a VR-based survival swimming class where each student can use their own device. As teachers cannot check the learning attitudes of students in real time in a VR-based survival swimming class, the educational evaluation process is significant. Each participant employed quizzes, including simple questions, to perform their educational evaluations of students' knowledge after completing their VR experience. The participants completed quizzes with students and helped them understand relevant contents more deeply by providing detailed explanations of the answers. In addition, the use of VR and simulation devices has an advantage of triggering student curiosity. However, when these devices are used without appropriate controls, instructors might fail to deliver educational contents that should be included in a VR-based survival swimming class. However, all participants were aware of the problem that VR-based survival swimming classes were mainly conducted based on experience. To solve this problem, they completed a VR-based survival swimming class by summarising the educational contents that had been covered in that lesson.

4.4. Self-feedback on classes

For survival swimming classes in schools, instructors are generally required to teach for 35 to 40 minutes per class period. However, the required teaching time for survival swimming education per class period might change depending on the school schedule. In survival swimming education applying VR and simulation devices, instructors must spend a few minutes setting up and installing these devices. For this reason, they encounter situations where they should teach classes continuously without a break time. In addition, survival swimming instructors are required to hold classes in different schools every day. Accordingly, they must adapt to relevant factors such as the building arrangements and the atmosphere of the schools in which they hold classes. Hahn indicated that she was once affected by the movement and character of a homeroom teacher of the class in which she was supposed to teach students. As a result, she works to quickly identify the mood of the homeroom teacher and students in the corresponding class.

> *When I hold a 40-minute-long class, I tend to be unconsciously anxious for about five minutes in the beginning of the class. My voice shakes, and I try to read the mind of the homeroom teacher. I hold classes in many different schools, and the homeroom teachers in classes show different preferences for teaching styles. When I first worked as a survival swimming instructor, I was concerned about these issues a lot. It was the time when I taught survival swimming education in an elementary school located in Paju. The principal of the school told instructors including me that we should not eat something or even drink water indoors. As the principal had established an atmosphere like this, I was overwhelmed by the atmosphere and could not speak well for about ten minutes. It is the greatest weakness of my personality that I am easily affected by my surroundings.* (Hahn)

It has been less than a year as of this writing since survival swimming education applying VR and simulation devices was practically implemented in schools. Thus, the number of survival swimming instructors that have applied VR and simulation devices, including the research participants, was significantly low. Moreover, it can be reasonably assumed that most of these instructors had less than one year experience as a VR-based survival swimming instructors. Before these instructors began using VR and simulation devices, they would have also taught students in swimming pools. After the beginning of the COVID-19 pandemic, they would have held indoor classes using monitors and audio-visual materials. Ahn, who had maintained her previous teaching method for survival swimming education for several years, encountered considerable difficulty in converting this teaching method to a new one based on VR and simulation devices. She stated that she spent a significant amount of time helping certain students remain focused in her classes when they showed half-hearted learning attitudes. She selected this characteristic as her simultaneous strength and weakness.

> *I used to apply a standardised teaching method in classes, and it was very difficult to convert this teaching method to a new teaching method. But I should be aware of such difficulty all the time. I think that I should study more in the future, and I am so meticulous that I cannot bear students behaving half-heartedly in my class. Other instructors might pass over certain problematic behaviours of students flexibly if these behaviours are not too serious, but it is not the story of my life. In general, students cannot perform even what they have learnt perfectly as soon as they have a swimming class in general. They need more time to do so. Nevertheless, I have a tendency of informing students about a great and sufficient number of educational contents within a limited time. It is my concern that students might lose interest in the subject that I teach because of my tendency.* (Ahn)

4.5. Crucial elements for an instructor

Experience based on educational devices is the core of survival swimming education applying VR and simulation devices. However, the effects of such experiences can be doubled only when students are clearly aware of the class objectives and class contents prior to experiencing the VR contents and simulation. Ham selected the capacity of an instructor to express opinions as a necessary competence of a VR-based survival swimming instructor, given the need to inform students about contents related to his or her class and methods for experiencing VR contents. The instructors had recently taught students in indoor classes due to the COVID-19 pandemic. However, Ham addressed a need for survival swimming instructors to be flexible in responding to questions from students regarding survival swimming classes and methods for using VR and simulation devices.

> *Instructors' tone of voice and accent are important. Instructors should speak clearly enough to help students understand what they say well. Students find it more difficult to understand what I say these days because I have to wear a mask in a class. Instructors should also have the capacity to flexibly manage a situation when students ask weird questions or when a certain issue arises in a class. Instructors should develop their own*

teaching strategies for helping students concentrate in their classes and controlling students. (Ham)

In South Korea, certificates for survival swimming instructors are issued by organisations such as the Republic of Korea National Red Cross and the Korea Survival Swimming Association. To obtain these certificates, instructor candidates must complete various types of theoretical education and practical training and pass evaluation processes. In addition to possessing certificates, they should also spend an appropriate amount of time analysing teaching methods to help students understand what they learnt in class and increase students' interest in the class. In this way, they can facilitate smooth class operation in the practical survival swimming education field. Ahn commented that instructors should constantly conduct research on contents to be taught in classes and class operation methods so they can respond swiftly to questions from students about the class contents and establish a desirable class atmosphere.

> *I think that I should study relevant certificates and teaching methods by myself. When I watch other instructors teaching students, I find a difference between these instructors in detailed aspects. Experienced instructors have a different range of capacities for responding to students' questions from that of inexperienced instructors. Experienced instructors are used to providing more satisfactory answers and solutions based on their experience. For example, in CPR classes, experienced instructors show similar CPR performance regardless of the surrounding conditions. On the other hand, inexperienced instructors perform CPR at irregular speeds. The speed of their CPR performance will inevitably increase or decrease.* (Ahn)

5. Discussion

The research results can be summarised as follows. First, research participants began swimming to develop their career or hobbies as swimmers and naturally came to work as survival swimming instructors in adulthood. Second, research participants believed that using VR and simulation devices significantly contributes to teaching survival swimming and the educational operation of their classes. Third, research participants provided self-feedback on their classes and analysed factors they should develop as instructors.

This study derived the following implications based on the research results. First, as VR and simulator-based survival swimming classes utilise educational equipment (VR, simulator), the ability to adeptly handle educational equipment is considered a vital teaching capacity. If the focus of the VR devices is out of focus or the field of vision is not clear, the instructor needs to set up the VR devices so that the students can participate in the class.

Second, communication is a key capacity for instructors to effectively explain the class objectives and contents. Solid communication skills are required to achieve class goals and explain the use of educational equipment before commencing practice, answer students' questions after the practice, and organise the class. Practice education is conducted with one device per person due to the nature of the class. Therefore, if the time lag for completing the experience increases, there is a strong possibility of a setback in the class progress.

Third, instructors should possess the flexibility to deal with various unexpected or uncomfortable situations. For example, due to the nature of the survival swimming class, classes proceed in the classroom in the presence of homeroom teachers. In general, the homeroom teacher does little to intervene in the class. However, sometimes the homeroom teacher exerts a considerable influence in the class compared to the principal lecturer. In this case, it may disperse the children's attention. Therefore, the principal lecturer needs to be able to improvise to address unexpected situations within a short time and reorient students so that they concentrate on the class again.

The theoretical implication of the research results is that the use of VR devices induces interaction and indirect experiences so that students can expect similar learning effects without direct experiences. This has meaningful implications for situated learning and experiential learning theory. In addition, the practical implication is that by using VR devices, instructors can expect learning effects while securing safety. (Araiza-Alba et al., 2021)

6. Conclusion

This study analysed the teaching capacities of survival swimming instructors applying VR devices. In-depth interviews were conducted with four instructors applying VR devices who described their motivations for having begun working in this field and various cases from their experiences. Detailed interviews focused on examining participants' capacities for teaching survival swimming. An inductive analysis of the research data obtained from these interviews was carried out to classify the data into the categories of motivation for having begun working as a survival swimming instructor and strategies for teaching survival swimming. The research results showed what teaching capacities were required for effective VR-based swimming lessons. The result also indicated that survival swimming education applying VR and simulation devices indirectly provided students with VR-based educational contents and allowed them to gain similar experience, interests, and enjoyment to what they obtained in previous traditional training classes for survival swimming. Therefore, it is expected that VR-based survival swimming education can boost students' learning performance and interest in survival swimming education.

7. Limitations and Future Research

There are several limitations to the research method used in this study. Based on the analytical results, this study presents several suggestions for follow-up studies in relevant fields.

First, although random selection was employed, this study was carried out based on only a few participants who were all female and working as survival swimming instructors in metropolitan area. Therefore, the results cannot be generalised to all survival swimming instructors using VR devices. Follow-up research should pay attention to participant selection by matching the characteristics of a group of participants with research purposes.

Second, this study intensively analysed the teaching capacities deemed necessary according by the participants. However, this study did not collect or analyse research data regarding teaching capacities for survival swimming instructors

who are not applying VR and simulation devices. Future studies could compare swimming instructors using traditional methods with the research participants of this study.

Finally, future studies should evaluate the practical performance of survival swimming learners in actual swimming pools after the end of the COVID-19 pandemic to verify the effectiveness of VR-based survival swimming education.

8. References

Araiza-Alba, P. Keane, T., Matthews, B., Simpson, K., Strugnell, G., Chen, W.S., Kaufman, J. (2021). The potential of 360-degree virtual reality videos to teach water-safety skills to children, *Computers & Education*, 163,104096. https://doi.org/10.1016/j.compedu.2020.104096.

Bae, Y., Park, P., Moon, G.S., Yoo, I., Kim, W., Lee, H., & Shin, S. (2018). An Instructional design of STEAM programs using virtual reality equipment and analysis of its effectiveness and attitude of learners. *Journal of The Korean Association of Information Education*, 22, 593~603. http://dx.doi.org/10.14352/jkaie.2018.22.5.593.

Cheng, J. (2021). Evaluation of physical education teaching based on web embedded system and virtual reality. *Microprocessors and Microsystems*, 83, 103980. https://doi.org/10.1016/j.micpro.2021.103980.

Clark, D. (2006). *Games and e-learning*. Epic. [Online]. Available: http://www.cedma-europe.org/newsletter%20articles/misc/Games%20and%20e-Learning%20(Nov%2006).pdf. Retrieved March 16, 2022.

Creswell, J. W. (1998). *Qualitative inquiry and research design: Choosing among five traditions*. Sage.

Dewey, J. (1938). Experience and Education. Collier Books.

Dey, I. (1993). *Qualitative data analysis: A user-friendly guide for social scientists*. Routledge. https://doi.org/10.4324/9780203412497.

Dunleavy, M. (2014). Design principles for augmented reality learning. *Tech Trends, 58*(1), 28–34. https://doi.org/10.1007/BF02766777.

Elmqaddem, N. (2019). Augmented reality and virtual reality in education. Myth or reality? *International Journal of Emerging Technologies in Learning*, 14(3), 234-242. https://doi.org/10.3991/ijet.v14i03.9289.

Guba, E. G. (1981). Criteria for assessing the trustworthiness of naturalistic inquiries. *Educational Communication and Technology Journal*, *29*, 75–92 https://doi.org/10.1007/bf02766777.

Jeon J., & Cho, S. (2007). 초등학교 체육수업에 대한 특별편입교사의 인식분석 [Cognition analysis on the physical education teaching of elementary specially enlisted teachers]. 학교보건체육연구소 논문집 [*The Journal of Institute of School Health & Physical Education*], *14*(1), 189–227.

Kamarainen, A. M., Metcalf, S., Grotzer, T., Browne, A., Mazzuca, D., Tutwiler, M. S., & Dede, C. (2013). EcoMOBILE: Integrating augmented reality and probeware with environmental education field trips. *Computers & Education, 68*, 545–556 https://doi.org/j.compedu.2013.02.018.

Kang M., Won, D. H., & Jo, W. (2021). 생존수영 의무교육에 대한 강사의 인식과 경험 [Instructor's perception and experience of compulsory education for survival swimming]. 한국스포츠사회학회지 [*Korean Journal of Sociology of Sport*], *34*(1), 23–33. https://doi.org/10.22173/ksss.2021.34.1.2.

Kavanagh, S., Luxton-Reilly, A., Wuensche, B., & Plimmer, B. (2017). A systematic review of virtual reality in education. *Themes in Science and Technology Education*, 10(2)2, 85-119. https://eric.ed.gov/?id=EJ1165633.

Kim, D., & Ko, Y. J. (2019). The impact of virtual reality (VR) technology on sport spectators' flow experience and satisfaction, *Computers in Human Behavior*, 93, 346-356, https://doi.org/10.1016/j.chb.2018.12.040.

Kim, J. (1997). 체육학 연구법[*A method of physical education*]. 대한 미디어 [Korean Media].

Kim, J.-H., Kim, M., Park, M., & Yoo, J. (2021). How interactivity and vividness influence consumer virtual reality shopping experience: the mediating role of telepresence. *Journal of Research in Interactive Marketing*, 15(3), 502-525. https://doi.org/10.1108/JRIM-07-2020-0148.

Kim, Y., Kim, W., & Park, I. (2018). 생존수영 교육맥락의 질적 이해를 통한 교육내용과 지도자 전문성 개선 방안 탐색 [A study on the improvement of contents and expertise through qualitative understanding of the survival swimming educational context]. 한국스포츠교육학회지 [*Korean Journal of Sport Pedagogy*], *25*(1), 75–103. https://doi.org/10.21812/kjsp.2018.01.25.1.75.

Klopfer, E., Perry, J., Squire, K., Jan, M. F., & Steinkuehler, C. (2005). Mystery at the museum–A collaborative game for museum education. *Proceedings of Conference on Computer Support for Collaborative Learning*, 316–320. https://doi.org/10.3115/1149293.1149334.

Klopfer, E., Squire, K., & Jenkins, H. (2002, August). Environmental detectives: PDAs as a window into a virtual simulated world. *Proceedings of IEEE International Workshop on Wireless and Mobile Technologies in Education*, 95-98. https://doi.org/10.1109/WMTE.2002.1039227.

Kolb, D.A. (1984). Experiential Learning: Experience As The Source Of Learning And Development. Prentice-Hall.

Kwon, T., & Jung S. (2021). Elementary school teachers' survival swimming education burdens and improvement plans. *The Korean Journal of Elementary Physical Education*, 27(1), 51-71. https://doi.org/10.26844/ksepe.2021.27.1.51

Kwon, Y., Yeo, K., & Noh, Y. (2019). 델파이 기법을 활용한 생존수영 프로그램 개발을 위한 요인 도출에 관한 연구 [A study on derivation of factors for developing survival swimming program using Delphi technique]. 한국체육정책학회지 [*Journal of Korean Sport Policy*], *17*(4), 143–160. https://doi.org/10.52427/kssp.17.4.10.

Lackey, S. J., Salcedo, J. N., Szalmam J.L., & Hancock, P.A. (2016). The stress and workload of virtual reality training: the effects of presence, immersion and flow. *Ergonomics*, 59(8), 1060-1072. https://doi.org/10.1080/00140139.2015.1122234.

Lee, C. (2003). 여가학 연구방법론 [*A methodology for the study of leisure studies*]. 대경북스 [Daegyeong Books].

Lee, C. (2004). 가상현실, 별 만들기 [*Virtual reality, making stars*]. 동과서 [East and West].

Lee, Y., Kim, M. (2020). 생존수영 강사의 핵심역량 구성요소 및 우선순위 분석 [An analysis of survival swimming instructors of core competencies of factors and priority]. 한국체육교육학회지 [*Journal of Korean Society for the Study of Physical Education*], *25*(2), 51–62. https://doi.org/10.15831/jksspe.2020.25.2.51.

Milgram, P., & Colquhoun, H. (1999). A taxonomy of real and virtual world display integration. *Mixed Reality: Merging Real and Virtual Worlds, 1*(1999), 1–26. https://doi.org/10.1007/978-3-642-87512-0_1.

Ministry of Education (2016). 2016 school sports promotion plan. Department of Personality, Physical Education, and Arts.

Nelson, T. O. (1990). Metamemory: A theoretical framework and new findings. *Psychology of Learning and Motivation*. 26, 25-173. https://doi.org/10.1016/s0079-7421(08)60053-5.

Neubauer, B.E., Witkop, C.T., & Varpio, L. (2019). How phenomenology can help us learn from the experiences of others. *Perspectives on Medical Education*, 8, 90–97. https://doi.org/10.1007/s40037-019-0509-2.

Park, J. (2020). 코로나 19 상황에서 가상현실 (VR) 소프트웨어를 활용한 초등학생 생존수영교육이 운동자기효능감과 수상안전의식에 미치는 영향 [Effects of elementary school students survival swimming education using virtual reality (VR) software in the corona-19 situation on exercise self-efficacy and water safety awareness]. 한국체육과학회지 [*The Korea Journal of Sports Science*], *29*(6), 315-326. https://doi.org/10.35159/kjss.2020.12.29.6.315.

Parong, J., Pollard, K. A., Files, B. T., Oiknine, A. H., Sinatra, A. M., Moss, J. D., Passaro, A., & Khooshabeh, P. (2020). The mediating role of presence differs across types of spatial learning in immersive technologies. *Computers in Human Behavior*, 107, 106290. https://doi.org/10.1016/j.chb.2020.106290.

Patton, M. Q. (2002). *Qualitative evaluation and research methods* (3rd ed.) Sage.

Perry, B. (2014). Gamifying French language learning: A case study examining a quest-based, augmented reality mobile learning-tool. *Procedia-Social and Behavioral Sciences, 174*, 2308–2315. https://doi.org/10.1016/j.sbspro.2015.01.892.

Piovesan, S. D., Passerino, L. M., & Pereira, A. S. (2012, Oct 19-21). Virtual reality as a tool in the education. *International Association for Development of the Information Society International Conference on Cognition and Exploratory Learning in Digital Age*, 295–298. https://eric.ed.gov/?id=ED542830.

Sacks, R., Perlman, A., & Barak, R. (2013). Construction safety training using immersive virtual reality. *Construction Management and Economics, 31*(9), 1005–1017. https://doi.org/10.1080/01446193.2013.828844.

Servotte, J.-C., Goosse, M., Campbell, S. H., Dardenne, N., Pilote, B., Simoneau, I. L., Guillaume, M., Bragard, I., & Ghuysen, A. (2020). Virtual reality experience: Immersion, sense of presence, and cybersickness. *Clinical Simulation in Nursing*, 38(C), 35-43. https://doi.org/10.1016/j.ecns.2019.09.006.

Slater, M. (2018). Immersion and the illusion of presence in virtual reality. *British Journal of Psychology*, 109(3), 431-433. https://doi.org/10.1111/bjop.12305

Squire, K., & Klopfer, E. (2007). Augmented reality simulations on handheld computers. *Journal of the Learning Sciences, 16*, 371–413. https://doi.org/10.1080/10508400701413435.

Sun, H. (2020). 생존수영 교육에 대한 초등 여교사들의 인식 [Awareness of primary female teachers in survival swimming education]. 한국스포츠학회 [*The Korean Journal of Spor*t], *18*(1), 299–310.

Vaismoradi, M., Turunen, H., & Bondas, T. (2013). Content analysis and thematic analysis: Implications for conducting a qualitative descriptive study. *Nursing & Health Sciences*, 15(3), 398-405. https://doi.org/10.1111/nhs.12048.

van Duijn, T., Ng J.L., Burnay, C., Anderson, N., Uehara L., Cocker, K., & Button, C (2021). The influence of equipment and environment on children and young adults learning aquatic skills. *Frontiers in Psychology*, 12, 733489. https://doi.org/10.3389/fpsyg.2021.733489.

Velev, D. & Zlateva, P. (2017). Virtual reality challenges in education and training. *International Journal of Learning and Teaching*, 3(1), 33-37. https://doi.org/10.18178/ijlt.3.1.33-37.

Zhu, X., & Kou, F. (2021). Three-dimensional simulation of swimming training based on Android mobile system and virtual reality technology, *Microprocessors and Microsystems*, 82, 103908. https://doi.org/10.1016/j.micpro.2021.103908.