Pre-service Primary and Secondary Teachers' Perceptions of the Potential of Virtual Reality for Teaching and Learning

LI, HONGHUAN

Pre-service Primary and Secondary Teachers' Perceptions of the Potential of Virtual Reality for Teaching and Learning

Honghuan Li

This dissertation is submitted for the degree of

Doctor of Education

School of Education

Durham University

June 2021

Statement of Copyright

Abstract

Pre-service Teachers' Perceptions of ICT and Virtual Reality

Honghuan Li

In this thesis, three separate but closely connected studies were conducted. A scoping review employed a systematic approach to identify studies dealing with pre-service teachers' ICT beliefs, revealed the crucial factors in terms of measuring pre-service teachers' ICT beliefs, explored unresolved issues with the current literature of pre-service teachers' beliefs of different technologies, and provided clear directions for the development of further educational research and practice. A systematic review sought to examine the ICT beliefs of pre-service teachers containing the variables of ICT beliefs measurement, ICT adaptation factors and ICT training needs. The findings from the scoping review and systematic review revealed the relevant research and provided insights into the possible ways to measure pre-service teachers' ICT beliefs. A mixed method empirical study on pre-service teachers' beliefs and training needs on the educational use of virtual reality was conducted to fill the research gap and move the literature forward, as the results of scoping review and systematic review have suggested that there is a lack of evidence about pre-service teachers' beliefs on cutting-edge technologies, such as virtual reality technology. It was found that pre-service teachers have moderately positive attitude towards ICT and virtual reality technology in terms of openness to new ICT tools, perceived usefulness, perceived ease of use, and technological complexity; however, they hold a relatively positive expectation for the future development of virtual reality technology in the educational field. The results also showed that pre-service teachers have moderately positive attitudes towards ICT training, and they have clear goals about their training needs to guide their implementation of virtual reality technology in classroom teaching and learning. It is suggested that pre-service teachers in China need to adapt to the recent and newest policies for their own development and for the advancement of society. Future research could be based on the relationship between pre-service teachers' ICT beliefs and the practices of integration of technology in the classroom, as well as the changes in pre-service teachers' perceptions of ICT and cutting-edge educational technologies before and after the Covid-19 pandemic for teaching practice.

Figure 1. Word Cloud of the Thesis Generated by Nvivo

Acknowledgements

I had great time studying at Durham University and I gratefully acknowledge the support from my supervisors, examiners, and my parents for the completion of my EdD thesis.

I would like to express my dearest gratitude to my principal supervisor, Professor Steve Higgins. I am fortunate to have your support, your advocacy, and your faith on the completion of the thesis. You are the epitome of excellent mentorship and advisor with expertise and insights. Also, I would like to express my most sincere gratitude to Professor Carole Torgerson for the advice on my thesis construction, and Dr Dimitra Kokotsaki for your enormous encouragement during my thesis stage.

I would like to express my greatest appreciation to my EdD examiners, Professor Gary Beauchamp and Professor Mike Fleming for engaging with me in a constructive discussion about this thesis and making the viva a rewarding and memorable experience.

I must express my most profound gratitude to my parents for unwavering love, unfailing support and continuous encouragement. There are so many things I would need to thank you that cannot fit within words. You are both amazing and I am lucky to have you as parents to whiteness my important moments and achievements. Thank you for loving me exactly as I am.

Thank you all!

Table of Contents

List of Tables and Figures

1. Introduction

Overall, this thesis is divided into seven chapters. The introductory chapter gives a general information on the structure of the thesis and the main purposes of each chapter. The second chapter provides the necessary background information for the conduct of three different studies in this thesis, including virtual reality in language learning and teaching, teacher education in China, and education informatization policy in China. Chapter three presents a scoping review of pre-service teachers' ICT beliefs. The aim of the scoping review is to explore the extent of existing literature with regard to pre-service teachers' ICT beliefs, to identify the potential purview of a further systematic review, to identify the research gaps, and guide the directions of the empirical research in the later stage of the thesis. In chapter four, a systematic review is employed to further examine the ICT beliefs of pre-service teachers. The primary goal of the systematic review is to identify studies which examine the influence of pre-service teachers' ICT beliefs and perceptions of their own and their students' ICT use in the classroom, as well as to provide a guidance for the empirical research in the next chapter. The evidence synthesis in the scoping review in chapter three offers an ideal approach to discover the scope or coverage of the literature in a specific topic area, while the systematic review in chapter four employs a more rigorous and more detailed method with a predefined approach to synthesize international evidence in relation to particular questions by producing a more reliable finding; therefore, the combination of the scoping review and the systematic review in this thesis covers both the breadth and depth of the evidence of pre-service teachers' ICT beliefs.

Chapter five, followed by the synthesized evidence and suggestions from the scoping review and systematic review in chapter three and chapter four, contains an empirical study to identify the perceptions of pre-service English teachers about virtual reality and their perceived training needs in China, by underpinning the policies related to teacher education and education informatization in China. The method of mixed-method data collection and data analysis helps to validate the outcomes between different sources of data and reach a deeper and more comprehensive understanding of the data gathered. The combination of interpretivist and pragmatist perspectives in the empirical study offers a landscape for interpreting the findings in relation to research questions from the collected data, and by having range of results, addresses the findings of the research to benefit future educational praxis. As the main aim of this doctoral study is understanding pre-service teachers' ICT beliefs in general, and their perception of VR technology and training needs in particular, the selection of pre-service teachers in the empirical study serves the overall aim of the doctoral study. For convenience these were pre-service teachers of English as this was my personal background and a possible educational context for the deployment of VR technology. Although the thesis has provided the research background on virtual reality in language teaching and learning, further literature review in relation to the theories of technology in language teaching and learning was not covered in depth because the focus of the empirical study was aligned with the broad overall aim of the thesis, rather than specific subject issues relating to technology and language teaching.

Chapter six demonstrates my reflection of learning and teaching on how I put effort on gaining international insights on higher education during my professional doctorate journey. At last, this thesis concludes with a summary of the

main findings and implications from Chapter three to Chapter five in relation to the proposed review questions and research questions, along with the concluding remarks for this thesis.

2. Research Background

2.1 Virtual Reality in Language Teaching and Learning

The technology of virtual reality, which has become more popular in the last decade, is generated by the application of image composition, graphic design, and multimedia in this booming graphical computing era (Knott, 2000). Virtual reality has various definitions among scholars, such as "the idea of human presence in a computer-generated space" (Hamit, 1994), or "a highly interactive, computer-based, multimedia environment in which the user becomes a participant with the computer in a virtually real world" (Pantelidis, 1993, p. 23). In later definitions, scholars describe virtual reality based on its context and characteristics. Foster and Meech (1995) defined virtual reality in social context as some form of immersive, synthetic environment which creates a feeling of presence or suspension of disbelief which is sufficient to make the user feel that the artificial world which they appear to inhabit is "real". Similarly, I^3 , which stands for "Immersion, Interaction, Imagination", is proposed by Burdea and Coiffet (2003) to define virtual reality. Virtual reality is sometimes used in clinical settings especially for anxiety disorder treatment, such as phobias, panic disorders, post-traumatic stress disorder and generalized anxiety disorder (e.g., Botella et al., 2007; Gerardi, Rothbaum, Ressler, Heekin, & Rizzo, 2008; McCann et al., 2014; Öst, Brandberg, & Alm, 1997), and for stress management in non-clinical situations (e.g., Gaggioli et al., 2014), but has more recently reached the field of education.

McLellan (1994) has classified virtual reality into four categories: immersive virtual reality, projected reality, cyberspace, telepresence. Another classification of virtual reality is the distinction between the immersive virtual reality (hard virtual reality) and the desktop-based virtual reality (soft virtual reality) proposed by Schwienhorst (1998). Immersive virtual reality usually involves interfaces worn by the user, such as head-mounted display (HMD), wired or wireless gloves, hand controller or body suit, and the audio system that can provide binaural or three-dimensional sound. Desktop-based virtual reality, similar to projected reality, is much simpler than immersive virtual reality, which merely relies on traditional input and output devices such as a keyboard, mouse, monitor, graphics, video camera, microphone, and speakers. The concept of presence is central to virtual reality (Biocca, 1997), including self-presence (self-consciousness and identity), presence with others, and sense of physical presence in the virtual world. In this three-dimensional, computer generated shared virtual space, virtual reality is a promising tool to be explored in the area of education.

The research from Keskitalo (2011) aimed to devise a pedagogical model for virtual reality and simulation-based learning and made hypotheses on "teachers use pedagogical models and methods, as well as educational tools, as educational resources" (p. 137). Eight teachers were selected and interviewed with regard to the background information, teachers' perception on pedagogical thinking, potentials and challenges of using virtual reality systems, teachers' role, pedagogical models and methods, strength of the pedagogical community, and the need for teachers'

participation in development work. The interviews were transcribed and analyzed by themes using content analysis. The results showed that teachers emphasized the significance of learning by doing, which echoes the idea of "active epistemology" (Lonka, Joram, & Bryson, 1996). Learners prefer to acquire knowledge by themselves instead of having it "poured into" them, which is perceived as active learning. Also, some teachers mentioned that they rely on the constructivist approach of learning, so teachers saw themselves more as instructors and facilitators instead of knowledge transmitters. Teachers use the learning process by using stimuli (problems or examples) in the real world and build the connections between theory and practice (Bruce & Gerber, 1995; Laksov, Lonka, & Josephson, 2008). As for the virtual reality and simulation-based learning environment (Virtual Center of Wellness Campus, from Finland), the most frequent pedagogical model applied and mentioned for the environment learning was problem-based learning because it addresses real-life problems, and teachers would use different pedagogical methods in different ways. Some teachers described their virtual reality course settings similar to the learning through simulation models. They set learning goals, orient and motivate students (Orientation), address real world issues in the simulation-based training (Briefing), and use student centered immersive learning (Debriefing). However, they found that the last stage, debriefing, was challenging, and the planning of the teaching could change according to teaching objectives or the student groups. The fears from the teachers of using the equipment and environment could impede them using virtual reality and simulation-based learning environment.

Since virtual reality has provided a more productive and creative method of human interaction with computers than the traditional Graphical User Interface (Halfhill, 1996), Stone (1996, p. 11) has summed up the mutual, simultaneous, and spontaneous partnership as follows: "Interactivity implies two conscious agencies in conversation, playfully and spontaneously developing a mutual discourse, taking cues and suggestions from each other as they proceed." In this description, the interactivity between two agencies refers to the activity between human and computers. However, Schwienhorst (1998) has argued the nuance difference between the term "interaction" and "interactivity" by referring two reciprocal partnerships in virtual reality. "Interaction" means the communication between human and human, while "interactivity" refers to the communication between human and computer. Interaction is focused on two central points, i.e., collaboration and learner autonomy. The virtual space creation needs the consideration of the interactions among users; thus, the social interaction is one of the major factors of creating virtual reality learning environment. The emphasis on the importance of collaboration in developing learner autonomy has been stated in the literature (e.g., Little, 1995; Little, 2007; Tort-Moloney, 1997). In terms of tandem learning, interaction not only refers to the exchange among learners but also points to the supported performance, that is, "zone of proximal development" proposed by Soviet psychologist Vygotsky. Therefore, the shared spatial learning experience is an important factor in fostering interaction in virtual reality that is separated from the real world, but tandem learning can be developed in virtual reality, which includes reciprocity and learner autonomy (Little & Brammerts, 1996; Schwienhorst, 1998).

As the learner has developed and processed autonomous learning behaviors gradually, virtual reality can offer a third place, an alternative to the formal and traditional chalk and blackboard classroom environment, neither at home nor workplace, to immerse the learner into another space. The space itself can be means of encouraging and

enhancing learning activities because virtual reality allows learners to interact with the components in the virtual space, and to enhance the understanding process of the synthesized information in a revolutionary way, by reducing the need for abstract thinking (Carr & England, 1995). Therefore, the concept of interactivity is still necessary and essential in virtual reality. Knowledge construction is not only based on the interaction between learners but also the interactivity between the learner and the computer. Bruckman and Resnick (1995) have pointed out that personal meaningful outcomes can be constructed by engaging in effective activities. The combination of two strands (Papert, 1993), i.e., learning as an active process and the built-in authentic resources, has come to be the foundation of constructionism. The shared 3D space and shared activities in the third world using active learning strategies and built-in authentic learning materials will encourage and impel the support and incentives for learning. The creation of social interaction and collaborative learning facilitation could also be boosted in virtual reality in terms of tandem or paired learning experiences.

The literature about virtual reality implementation in language teaching and learning is prolific and detailed. C. Qu, Ling, Heynderickx, Brinkman, and Urgesi (2015) evaluated the role of virtual bystanders in language lessons and drew several conclusions based on their experiment. Participants wore a head-mounted display, finger clip and two finer electrodes in the virtual environment. There were eight virtual bystanders, or virtual students, in the virtual classroom and each student had a name card in front of the sitting desk. The participants sat in a U-shaped classroom, two virtual bystanders on the left and six virtual bystanders on the right. The bystanders were all non-native English speakers, and their gender was generated by computer randomly with the sex ratio of 1:1. The virtual teacher was a native English speaker, of well-dressed male appearance, neutral to the words or behaviors happened in the virtual classroom. The teacher first posted four questions to different virtual bystanders, and then the teacher would address each participant by saying, “How about you?”. If the participant provided an answer of less than 5 seconds, the teacher would ask a why-related question. The virtual bystanders would discuss and show different gestures or behaviors according to participants’ response. This piece of research suggests that if virtual bystanders expressing positive response to participants, the participants would hold more positive beliefs on self-efficacy, give longer answers and feel less anxiety, and vice versa. Negative attitudes would increase the heart rate of the participants and have a negative effect their participation. The participants’ feeling of presence was higher if bystanders exhibited a positive attitude towards them. Other research, such as Motor Simulation in Czech Language Learning (Repetto, Colombo, & Riva, 2015), the evaluation of Project-Based English Learning Environment (Xiaoluo, Chang, & Lizhi, 2010), the evaluation of Video-Capture English Learning (Yang, Chen, & Chang Jeng, 2010), and Chinese Idioms learning with virtual reality (Hu, Su, & He, 2016), have similarly explored practical aspects of participation in language learning activities.

2.2 Teacher Education in China

Teacher education, Shi Fan Jiao Yu in Chinese, aims to cultivate future teachers in normal universities in China. Normal universities are institutions of higher education where the teachers in China receive their training, like teachers’ colleges, and they also offer a range of programs for prospective college students. In terms of teacher education in China, researchers mainly focus on the topics such as the importance of teacher education, the

development of teacher education, the current policies on the enhancement of teacher education, the challenges and prospect of teacher education. Teachers undertake the mission and responsibility to help students to acquire knowledge, competence, or virtue. Teachers also facilitate learning, impart knowledge and skills, and preach virtue especially as a profession. Thus, teachers are the first resources of the development of education and the pillars of national prosperity and strength, national revival, and the happiness of the people (GOV, 2018). Plans and measures related to long-term benefits are mostly based on education, and the education plan is mainly based on teachers because teachers are the root of establishment and development of education. In addition, teacher education is the key and basic resource of being a powerful educational country, the key link of teacher training and the source of strengthening teaching staff, and the key to cultivate more outstanding teachers.

At the National Conference on Education, President Xi Jinping pointed out that we should strengthen the system of teacher education, increase support for teachers' colleges and universities, efficiently operate teachers' colleges and universities, and effectively construct teacher education programs. The National Action Plan for the Revitalization of Teacher Education (2018-2022) (MOE, 2018) points out that teacher education is the cornerstone of education as well as the driving force of improving education quality and regards high-level construction of teacher education base as a comprehensive revitalization of teacher education. The main purpose of teacher education is to train professional teachers. Also, the teacher education in higher institutions supports primary and elementary education in China, and it plays an important role in accelerating the modernization of education and society (Qu & Jiang, 2019). The cultivation of talents depends on the construction of teaching staff, which contains important and strategic meaning to the development of teacher education. Meanwhile, enhancing the construction of education teams is an indispensable part of teacher education development in China.

The development of teacher education in China can be divided into three stages since the establishment of the People's Republic of China: the stage of system construction, the stage of optimized coordinated development, and the stage of transformation and innovation (Qu & Jiang, 2019; Zhou, 2019). During the system construction stage (1949-1976), the main task was the restoration, expansion, and renovation of teacher education. At the First National Conference on Education, the policy of traditional education system renovation and the development of new education system was established; consequently, the proposals of improving Beijing Normal University and other normal colleges nationwide were put forward. Provisional Regulations on Beijing Normal University was issued by the Ministry of Education, which constituted the basic model of teacher education in higher education and played a leading role in the restoration and renovation of teacher education nationwide. The first teacher education conference held by the Ministry of Education determined the fundamental principle by establishing at least one independent normal university or college in each major administrative area, plus one junior teachers' college in each province or major city. The draft resolution of teacher education was issued by the Ministry of Education. It established the mission of the normal university or college to train teachers for senior high schools, and the mission of junior teachers' college to train teachers for junior high schools. The training program, curriculum and the training system of teacher education were initiated. Instructions on improving and developing teacher education in higher

education were provided by the Government Administration, which proposed that teacher education should be vigorously developed.

During the stage of optimized and coordinated development (1977-2000), suggestions on how to strengthen and develop teacher education were proposed by the Ministry of Education, which gave priority to the development of teacher education and offered a better guide to the restoration, innovation, and development of teacher education in higher education. The fourth national conference on education established the strategic position of teacher education that promoted the comprehensive restoration and innovation of teacher education in higher education into a new level. The strengthening of the professional development of teaching staff in colleges and proficient operation of junior teachers' colleges were proposed by the MOE to constitute a complete system of teacher education. In addition, decisions on the reform of the education system made by the Central Committee of the Communist Party of China placed great emphasis on the development and enhancement of teacher education in higher education as well. The enhancement and development of teacher education were also proposed by the State Education Commission, which required that the reform of teacher education should be geared to the needs of modernization, the world and the future, the popularization of nine-year compulsory education, and the enhancement of the level of primary and secondary education. It also emphasized that junior teachers' colleges were an important component of the system of teacher education, and it required that the development of junior teachers' college need to be improved and perfected in the future.

The Guidelines for the Reform and Development of Chinese Education issued by the State Council placed emphasis on the strategic importance of teacher education to train teachers in primary and secondary schools, which required that governments at all levels should operate vigorously efficient in teacher education. Several suggestions on the Reform and Development of Teacher Education also emphasized that Party committees and governments at all levels should realize the importance of teacher education, take the development of teacher education as strategic measures of giving priority to the development of education, and give priority to teacher education in the aspect of allocation of resources. Organizing the Implementation of the Program of the Reform of Teaching Contents and Curriculum System was proposed by the State Education Commission, which aimed at pushing the reform of teacher education into the 21st century, creating a new prospect of teacher education, enhancing the professional level of teacher education, and training qualified teachers for the new century. Later, the Action Plan for the Revitalization of Education geared towards the 21st century was issued by the Ministry of Education to enhance and reform teacher education, improve the quality of teacher education, and promote academic degree of the teachers of primary and secondary schools. The resolution of deepening the reform of education and promoting quality education called for the comprehensive universities and non-teacher training orientated colleges or universities to participate in teacher education, which is the innovation of teacher education and the promotion of the teacher education reform to a higher level.

During the stage of transform and innovation (from 2001 to nowadays), the Resolution on the Reform and Development of Primary and Secondary schools was passed by MOE, calling for the improvement and perfection of open teacher education system based on the existing normal universities and colleges together with the joint

participation of non-normal universities and colleges with a mode of connection between cultivation and training. The Action Plan for the Revitalization of Education (2003-2007) issued by MOE embodied the goals and characteristics of openness, high level, professionalism, and integration of teacher education. The quality and level of teacher education have been enhanced accordingly as well. Measures for the Implementation of Free Education Policy for the Students of Normal Universities directly under the Ministry of Education were taken to promote the reform of teacher education. The National Education Plan was made to enhance teacher education, constitute an open, flexible system of teacher education based on normal universities and colleges with the cooperation of non-normal universities and colleges. Proposals for Deepening the Reform of Teacher Education were put forward to develop the main role of normal universities and colleges in teacher education, put emphasis on the construction of further normal universities and colleges, bring the superiority of comprehensive disciplines of comprehensive universities into full play and offer strong support for the cooperation among normal universities, comprehensive universities and local governments in establishing the centers of collaborative innovation of teacher education.

The reform and development of teacher education in China are confronted with both challenges and opportunities. The basic direction of the development of teacher education is to improve the quality of teacher training, and form new trends of higher education for openness, lifelong education, integration and professionalization (Tang, Xun, Mu, & Meng, 2001). Teacher education in China has been a great achievement, but at the same time, some challenges should be noticed. The reform of teacher education is to emphasize and highlight the characteristic of teacher training, to bring the superiority of Chinese teacher education into full play. Consequently, China needs to run well teachers' colleges and universities according to the special national conditions and encourage graduates of non-teachers' colleges and universities to take up teaching by obtaining teacher certificates. It also needs to optimize the systems of examination of teacher certification, attach importance to teaching practice and select outstanding talents. The teacher education programs aiming to develop outstanding teachers for the countryside should be free nationwide. And the optimization in Master of Education and reform the training systems of the preschool teachers should be put forward, concerning both the quantity and the quality of teacher education (Gu, Hao, & Hu, 2017). At present, teacher education in China is not only influenced by the age of information technology but also by the principal contradiction facing Chinese society in a new era. Under such circumstances, the policies, systems, and focuses of the teacher education need to be strategically adjusted. In order to build the new system of teacher education, the priority should be given to attaching importance to teacher education, enhancing the quality of teacher education, improving the quality of sources of student teachers, deepening the reform of curricula and teaching of teacher education, and strengthening the cooperation among teachers' colleges, universities, primary and secondary schools (Wang, 2019).

More challenges and opportunities emerged at the end of 20th century, teacher training in China began to turn to the exploration of the reform of teacher education. The professionalization, diversification and integration of teacher education have been a prominent achievement, meanwhile incidental challenges should be given more reflection. When stepping into the new era, the reform of teacher education in China should be more practical and be based on national needs and the laws concerning education, in order to carry forward and develop the

advantages of traditional teacher education, learn from the experience of teacher education from the international point of view, aim to improve the quality of teacher education, perfect the system of teacher education with the characteristic of China, and provide guarantees for powerful and outstanding teachers in primary and secondary education (Cai, 2019). According to Zhao, Luo, and Zhao (2020), priority should be given to the development of education, safeguard of the status of teachers, and the revitalization of teacher education since the foundation of the country is based on education and education is based on teachers' education. Also, the revitalization strategy of teacher education is based on the leading role of normal universities, and normal universities are the main body of teacher education. Outstanding young people should be encouraged to be educated in teacher education programs so that we will have the chance to cultivate high-quality, professional, innovative, and outstanding teachers. Besides, the certification system for teacher education need be fully implemented; the elimination and withdrawal mechanism of normal education need be established; and strict examination and awarding system of teacher qualifications for normal university students need be reinforced as well. Through the quality authentication and qualification system, as a result, teacher education in normal universities is encouraged to train excellent teachers with their own characteristics.

2.3 Education Informatization Policy in China

Since the 1990s, China has been dedicated to start the process of Education Informatization. A key milestone of the process was the establishment of the CERNET (China Education and Research Network) in 1994 which was invested by Chinese government and managed by the Ministry of Education (L. Chen, Li, Huang, Li, & Wang, 2016; Y. Liu, 2016; Sui, Wang, Yang, Sun, & Yang, 2008). After building campus networks extensively, the Ministry of Education started the Network Courses Construction Project in 1999 and formulated the modern distance education standard system CELTS (Chinese E-Learning Technology Standards) framework (CELTSC, 1999). The term "Education Informatization" was generated with the development of the information and communication technology (ICT) and used as Jiaoyu-Xinxihua in Chinese. Some alternative forms of the term Education Informatization are still used in journal articles, such as Jiaoyu-Dianqihua/Jiaoyu-Dianzihua (Electronic Education), Jiaoyu-Shuzihua (Digital Education) and Jiaoyu-Zhihuihua (Intelligent/Smart Education) (Shi, Wang, & Li, 2015). ICT construction in education is a key factor for building comprehensive national power and national influence worldwide. Thus, in order to adapt to the latest trends of educational development and invisible competition among nations in the world, China is pursuing advanced and state-of-the-art Education Informatization based on the road of socialism consistent with Chinese national policy.

There are two perspectives among scholars in terms of defining the term Education Informatization in recent years by stressing the *process* of the Education Informatization and by stressing the *outcome* of the Education Informatization. Nan (2002) has suggested that Education Informatization is the process of utilizing current information technology to develop and optimize educational resources, cultivating and improving the students' information quality, and promoting the modernization of education progress. D. Liu and Li (2002) have defined the term Education Informatization as a series of revolutions and transformations to form a new education system based on the development of technology, including educational beliefs, educational organization, educational content,

educational mode, educational technology, educational assessment, and educational environment. Furthermore, Li (2004) has proposed that with the guidance of advanced education theories and by penetrating to every aspect of teaching and learning, Education Informatization can refer to the development, application, and utilization of educational resources actively, cultivation of adaptive, creative, innovative, and competent personnel, and the acceleration of establishing and achieving educational modernization project.

Another trend in defining the term is emphasizing the outcome of Education Informatization so as to achieve the goal of educational modernization. Chen and Wang (2002), for example, have pointed out that by achieving Education Informatization, we should develop and apply information technologies and information resources to build an educational environment that can easily adapt to social needs. In the similar vein, Lü (2004) has suggested that Education Informatization is by using information technology, especially the Internet, to transform teaching content, teaching method, and teaching approach in educational settings. In addition, He (2011) concisely defined the term as the general application and popularization of information and information technology in educational area and teaching department. As can be seen in the definitions given by different scholars, Education Informatization is a method or approach to achieve systematically educational reform and transform by utilizing information and communication technology either from the perspective of the process or from the perspective of the outcome. Therefore, the term Education Informatization is a multidimensional, evolutionary, and integrated concept aiming to cultivating innovative personnel, promoting a learning society, and realizing educational modernization both in teaching and learning.

The earliest Education Informatization policy can be traced back to 1978. At that time, former President Deng Xiaoping had a speech on paying attention to electronic education application. Since then, Education Informatization policies and regulations have been issued and published to accelerate the process of information and communication technology implementation in the educational field. Several scholars have documented chronology of the relevant policies, regulations, and events on Education Informatization in China (e.g., A, 2006a, 2006b; Zhang, 2009; H. Zhao & Ma, 2012). Each period of development of Education Informatization has had its own needs and focus due to the dynamic evolvement of the society. According to the characteristics of the regulations and the policies, H. Zhao and Ma (2012) have classified three different stages of Education Informatization in China, accordingly, the Initial Stage, the Comprehensively Carry-Forward Stage, and the Rapid Growth Stage.

In the Initial Stage (1978-1997), Chinese government has decided to embrace the opportunity for educational reform and boost computer education with the rapid development of information technology and the successful implementation of computer education in western countries. Seventeen key policy files and regulations were published in terms of the initial planning of computer education, the importance of computer devices in teaching and learning, the learning and teaching software development, and the aims of implementing computer education in primary and secondary schools. The Comprehensively Carry-Forward Stage (1997-2003) has witnessed the popularity of the computer and skills demanded by information technology. People were keen to be part in the popular trend in using information technology and the whole society aspired further development after the Internet being widely used in China; consequently, the Ministry of Education has acknowledged the significant role of information

technology in education and the term Education Informatization has been officially proposed in that stage. Thirty-six crucial policy files and regulations were published during the Comprehensively Carry-Forward Stage with regard to the establishment of evaluation and assessment system in educational software, the promotion of distance learning in higher education, the conduct of teacher training in information technology, the construction of digital campus, and the prompt of information technology development in rural areas.

In the Rapid Growth Stage (2003 till now), the development of Education Informatization has been promoted as a national strategy for the whole country to achieve the aim of education modernization. There are several key policies and regulations in this stage. Notice About the Education Revitalization Action Plan in 2003-2007 (MOE, 2004) has stated that the government will build the public information technology services by sharing software and hardware educational network, and by constructing the educational technology application platform in national level. The Outline for National Midterm and Long-term Educational Reform and Development Plan (MOE, 2010) is the most critical and strategic document in the latest stage which sets the direction of educational plan in the current decade (2010-2020). In March 20th, 2012, the Ministry of Education in China has published The Ten-Year Development Plan for Education Informatization (2011-2020) (MOE, 2012) that stresses the significant and revolutionary effects of ICT in education, as well as expects teachers to improve the ICT literacy and apply ICT in teaching praxis by means of ICT training (J. Zhao & Xu, 2010). As a country of information technology growth epicenter, at that time, China ICT studies have grown from 1989 to 2012, measured by the number of publications worldwide (Qiu & Bu, 2013).

Catching up with the needs and the trends of the national development plan is also embodied in the significance of research. On March 5th, 2015, Premier Li Keqiang spoke of the concept of “Internet Plus” in the annual Government Work Report (GOV, 2015), which entails integration of mobile Internet, cloud computing, big data, and Internet of Things with the industries in society. Later on December 16th, 2015, President Xi Jinping made the remarks at the opening ceremony of the Second World Internet Conference (WIC) in Wuzhen, Zhejiang Province. According to President Xi, China is now implementing the “Internet Plus” action plan, advancing the building of “Digital China”, developing the sharing economy, and supporting Internet-based innovation in all forms, with a view to improve the quality and efficiency of development. Since China has been focused on the “Internet Plus” strategy that pursues to be strong and prosperous by the integration of Internet technologies to advance the building of “Digital China”, it indicates the explicitness of the recent and future trends of industry development in China, including the field of education. With the help of “Internet Plus” strategy, it will empower the rapid development of digital education in China since the Internet can help unlock the full potential chance and opportunity by boosting efficiency and lowering costs in education for the achievement of Education Informatization. The Education Informatization Thirty-Five-Year Plan (MOE, 2016) continues to support the deployment of information technology in educational settings, aiming to achieve the Three-Link Project (campus network, campus WiFi, and web resources), Zhuandi-Ketang (full coverage of digital education resources), ZhongChuang Space (online educational resources) and the Internet Plus strategy.

The significance of the Education Informatization policy can be divided into two dimensions, namely, education beliefs and education practice. Kong (2003) has proposed that the crucial element of education beliefs is the relationship among education, society, people, and culture, which reflect the aim and the value of education, and the process of Education Informatization will definitely prompt changes in education beliefs. He also suggests that three points to explain his thoughts: 1) the Education Informatization has provided the opportunity for the society to cultivate more innovative talents with more diversified teaching and learning methods; 2) the Education Informatization has guided the exam-oriented education to quality-oriented education by adapting to social needs; and 3) the Education Informatization can both satisfy the education needs of all-around development and personality development by breaking through the limitation of space and time for activating the motivation of learner autonomy. In addition, Shi et al. (2015) has interpreted the education beliefs of Nan Guonong, the first person who brought the concept of electronic education to China that represents the latter stage of the Education Informatization development. There are two key characters in Nan's education beliefs, "Hua" (Transformation) and "He" (Integration). As a component of the scientific subject, "Hua" is the basic element of the Chemistry subject (Hua-Xüe). Oxidation-reduction reaction is a typical reaction in Chemistry like $2H_2 + O_2 = 2H_2O$. Just like this equation, the word "Information Technology" and "Education" can have the same oxidation-reduction reaction by mixing the Education Ion (E^+) and the Information Technology Ion (It^{2-}) to transform into Electrical Education: $2E_2 + It_2 = 2E_2It$. The word "He" in Chinese means Integration. There will be a time that vast and massive electronic educational resources exist on the Internet but when these resources are well combined (Youhua-Zuhe) and flexibly blended (Linghuo-Hunhe), the integration of the Electrical Education would be more universal to the educational field.

Another dimension of the significance of the Education Informatization policy is based on the digitalized campus environment, transformation of the platform of sharing educational resources and diversified teaching and learning methods implemented in the classroom (L. Chen, Chen, Zheng, & Li, 2015; L. Chen & Li, 2014; Y. Liu, 2016). The construction of the Intelligent Campus offers the possibility to connect the resources in the campus by managing the data and providing the services in an integrated platform. For example, students only need to use one campus card to access the learning and entertaining facilities and even to use it as a payment method in the campus; teachers can use the Tongyi-Menhu (Administration Platform) for the inter-communication, educational administration, project funding and students' management. The emergence of MOOCs (Massive Online Open Courses) is one of the productions of educational resources sharing platforms, such as Coursera (www.coursera.org), EdX (www.edx.org), Udacity (www.udacity.com), and FutureLearn (www.futurelearn.com). MOOCs are beneficial for higher education institutes, professors, and students. Jacobs (2013) believes that by making education more accessible to people worldwide, MOOCs ultimately democratize the way of education. In China, the constructing and polishing MOOCs platforms symbolize that China has the competence to achieve Education Informatization by following the world leading trend. In 2013, Peking University has set up its first cohort of courses on EdX. Later on, Tsinghua University has built the first Chinese version of MOOCs platform – Xuetang-Zaixian (www.xuetangx.com). There are other forms of cloud-based educational sharing platforms, such as Chinese Higher Education (www.icourse163.org), National Online Courses Resources (www.jingpinke.com), National Education Resources Public Services (www.eduyun.cn),

Chinese Open Courses (www.opencla.cntv.cn), and Love Online Courses (www.icourses.cn). Besides, the flipped classroom teaching is another production of educational reform. Flipped teaching and learning normally include teacher-created videos; in-class activities are needed, and include interactive activities (Waddell, 2012). Other forms of teaching and learning, such as SPOC (Small Private Online Course) and Wei-Ke (Micro-Lectures) are associated with the Education Informatization reform. In the future, 3D Printing, Kinetic Devices, Virtual Reality, Augmented Reality, Mixed Reality, Cloud-based Technology and Big Data are expected to be major trends in realizing Education Informatization.

2.4 Summary

This chapter provides a background to this research study and demonstrates the importance of the review of the literature on virtual reality in language teaching and learning, the informative background on teacher education in China, and the interpretive explanation of education informatization policy in China. It also provides the fundamental understanding of three independent but closely related studies for this thesis, i.e., the scoping review, the systematic review, and the empirical study. The scoping review can offer an ideal approach to discover the scope or coverage of the literature in pre-service teachers' ICT beliefs, identify the availability of literatures and studies in this field, to indicate an either broad or detailed overview on the map of evidence, and underpin a preliminary evidence-based scoping stage for systematic review. The systematic review in the later chapter aims to employ a more rigorous and more detailed method with a predefined approach, to establish the quality of gathered evidence, to synthesize international evidence on particular questions in relation to pre-service teachers' ICT beliefs and produce a more reliable finding. The combination of the scoping review and the systematic review in this thesis covers both the breadth and depth of the evidence of pre-service teachers' ICT beliefs and guide the empirical study which adopts mix methods to identify the perceptions of pre-service English teachers about virtual reality and their perceived training needs in China, by underpinning the literature on virtual reality in language teaching and learning, as well as the policies related to teacher education and education informatization in China.

3. Scoping Review: Pre-service Teachers' ICT Beliefs

3.1 Introduction

As a form of knowledge synthesis, a scoping review incorporates a process of mapping the existing literature or evidence base to identify patterns of themes in the area of research. In established fields where there is abundant evidence, a scoping review can provide a panoramic view and a holistic understanding of previous literature. According to Arksey and O'Malley (2005), Daudt, van Mossel, and Scott (2013), and Colquhoun et al. (2014b), a scoping review aims to map key concepts rapidly on a particular topic or research area, to identify types of evidence and research gaps to inform research, practice, and policymaking, especially where a defined area or field is complex and has not been synthesized before. Thus, the method of a scoping review can be employed for the following purpose: 1) to explore the extent of the literature in a particular domain in a minimal data synthesis without assessing the quality of included studies; 2) to summarize research findings and identify knowledge gaps; 3) to identify the potential scope of a systematic review by gathering a map or a snapshot of the existing literature; 4) to guide the priorities of future research, practice and policymaking directions by presenting the synthesis outcome.

The aim of this scoping review in this thesis is to explore the extent of existing literature with regard to pre-service teachers' ICT beliefs, to identify the potential purview of a further systematic review, to identify the research gaps, and to guide the empirical research in the later stage of the doctoral study. The approach for this scoping review is underpinned by Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement (Moher, Liberati, Tetzlaff, Altman, & Group, 2009) and the framework developed by Arksey and O'Malley (2005). This approach adopts a rigorous process and holist view of transparency during the scoping review which enables the replication of the search strategy and increases the reliability of the findings. It is organized by five distinct stages: 1) developing the initial research questions, 2) identifying relevant studies, 3) selecting studies with clear inclusion and exclusion criteria, 4) extracting and charting key information from the selected studies, and 5) summarizing and synthesizing the findings. The details of the five stages are described below.

3.2 Methods

3.2.1 Review Questions Development

To ensure that the scoping review generates and captures a sufficient breadth of coverage and substantial range of the literature relating to the topic of interest, the consideration and development of the research questions should cover all aspects of the research area in this scoping review. Articulating the research questions clearly is critical to the review process, which will guide subsequent stages of the review process and the structure of the report (Armstrong, Hall, Doyle, & Waters, 2011). Prior to conducting the formal process of the literature search, the purpose of the study and research questions were established. Drawing on the needs of the doctoral thesis and an initial scan of the literature, a broad question was posed in the review: what is known about the pre-service teachers' ICT beliefs? Since the focus of the review is an exploration of the critical research elements in the studies of pre-service teachers' ICT beliefs, the main rationale behind this broad question is to identify key aspects and research components of designing and conducting a piece of empirical research on pre-service teachers' ICT beliefs

for the later stage of doctoral research. Therefore, based on the focus and the rationale of the research, the following two review questions were raised to guide the review:

1) What are the topic categories in the literature on pre-service teachers' ICT beliefs?

2) What are the adopted methodologies of the literature on pre-service teachers' ICT beliefs?

3.2.2 Identification of Relevant Studies

In order to glean information and cover a broad range of available literature, a wide definition of key terms and a variety of sources for searching and capturing literature are recommended (Arksey & O'Malley, 2005). Key search terms and concepts were developed to identify the literature relating to pre-service teachers' or prospective teachers' beliefs or attitudes to ICT or technology. Electronic databases, hand searching, conferences, existing networks, and relevant websites were included in the literature searching sources. To maximize the permutations of terms scoped, the Boolean operators to combine, narrow or widen of the literature search, and the use of search tools to assist the searching process were adopted in the searching techniques. A university librarian was consulted to refine the key search terms, devise search techniques, and identify the relevant databases in the educational field for an optimized result. A search strategy was delineated which would yield the identification of the most relevant literature.

The search terms were of necessity devised broad and mapped based on thesauri since the goal was to conduct a broad instead of specific search of the literature. These terms were combined with Boolean operators to create search strings that could be useful to search in the electronic database and gray literature: (ICT OR "Information and Communication Technology" OR technology OR computer* OR digital OR IT OR "information technology" OR Internet) AND (perception* OR belief* OR attitude* OR confidence) AND ("teacher education" OR pre-service OR "student teacher*" OR prospective).

The following seven electronic databases were searched: Scopus, Web of Science, ERIC, JSTOR, ScienceDirect, British Education Index, and ProQuest Dissertation. In addition, attempting to uncover additional literature, a hand search of the grey literature includes in the reference lists from Google Scholar, Research Gate, and other sources on the web. Different search engines or databases required different search tactics or different search string styles but always kept with the same search keywords. The linked search strings developed in Scopus are outlined in Table 1.

Search Strings in Scopus
(TITLE (ict OR "Information and Communication Technology" OR technology OR computer* OR digital OR it OR "information technology" OR internet) AND TITLE (perception* OR belief* OR attitude* OR confidence) AND TITLE ("teacher education" OR pre-service OR "student teacher*" OR prospective)) AND PUBYEAR > 2000

Table 1. Search Strings Example

The inclusion and exclusion criteria identified directly from the research questions to guide this scoping review to provide comprehensiveness and transparency in the identification of primary evidence. The time period of the literature is set to the studies in the 21st century that is considered appropriate for the time period of technology development. All literature database searches are limited to English language articles. The full list of inclusion and exclusion criteria are outlined in Table 2.

Criteria	Inclusion	Exclusion
Type of Study	Empirical studies reporting quantitative or qualitative data	Studies are descriptive instead of empirical
Study Focus	Pre-service teachers' beliefs or attitudes toward ICT and various technologies	Pre-service teachers' beliefs about anything else other than ICT or technologies
Population and Sample	Pre-service teachers of all disciplines in recognized universities/colleges or equivalent level	All other teachers are not pre-service teachers
Language	English	Non-English studies
Time Period	Studies published or unpublished in the public domain from 2000 to 2018 (after 21st century)	Studies outside these dates

Table 2. Inclusion and Exclusion Criteria

3.2.3 Studies Selection

The employment of a broad search with key terms generated a list of 756 records. Search logs were documented during the literature search process. The initial search result is provided in Table 3. All 756 records from 8 sources were imported into Covidence and 219 duplicates were removed in the records. 537 studies were included in the first stage screening: the title and abstract screening. In order to document the whole review process in one place, Microsoft Excel spreadsheets were used for the later screening and data extraction activities. The review of the titles and abstracts has revealed that 264 studies were irrelevant including 7 duplicates found in Excel; those studies had primarily no relation to ICT beliefs or perceptions, pre-service teachers, and teaching activities with technologies. 274 studies were included in the second stage screening: full-text screening. Of which 29 full-text articles were retrieved and obtained from British Library document delivery service, or by contacting authors via ResearchGate or via email. This process has offered an additional way to discover and identify any additional or further relevant studies that could be included in the review list. By means of this assessment, 76 Studies were excluded from the full-text screening process (including no access to full text, the non-English language in the full text, irrelevant topics to pre-service teachers' ICT beliefs, and duplicates). As a result, 198 studies were included in the corpus for the final stage of the scoping review.

Database and Sources	Search Date	Results
Scopus	23-03-2018	155
Web of Science	23-03-2018	223
ERIC	23-03-2018	133
JSTOR	23-03-2018	51
ScienceDirect	23-03-2018	38
British Education Index	23-03-2018	0
ProQuest Dissertation	23-03-2018	42
Google Scholar	26-03-2018	114
	In total	756

Table 3. Search Results

The process of studies selection is followed by the inclusion and exclusion criteria and the PRISMA Statement (Moher, Liberati, Tetzlaff, Altman, & 2009). Figure 2 below illustrates the process of overall studies selection.

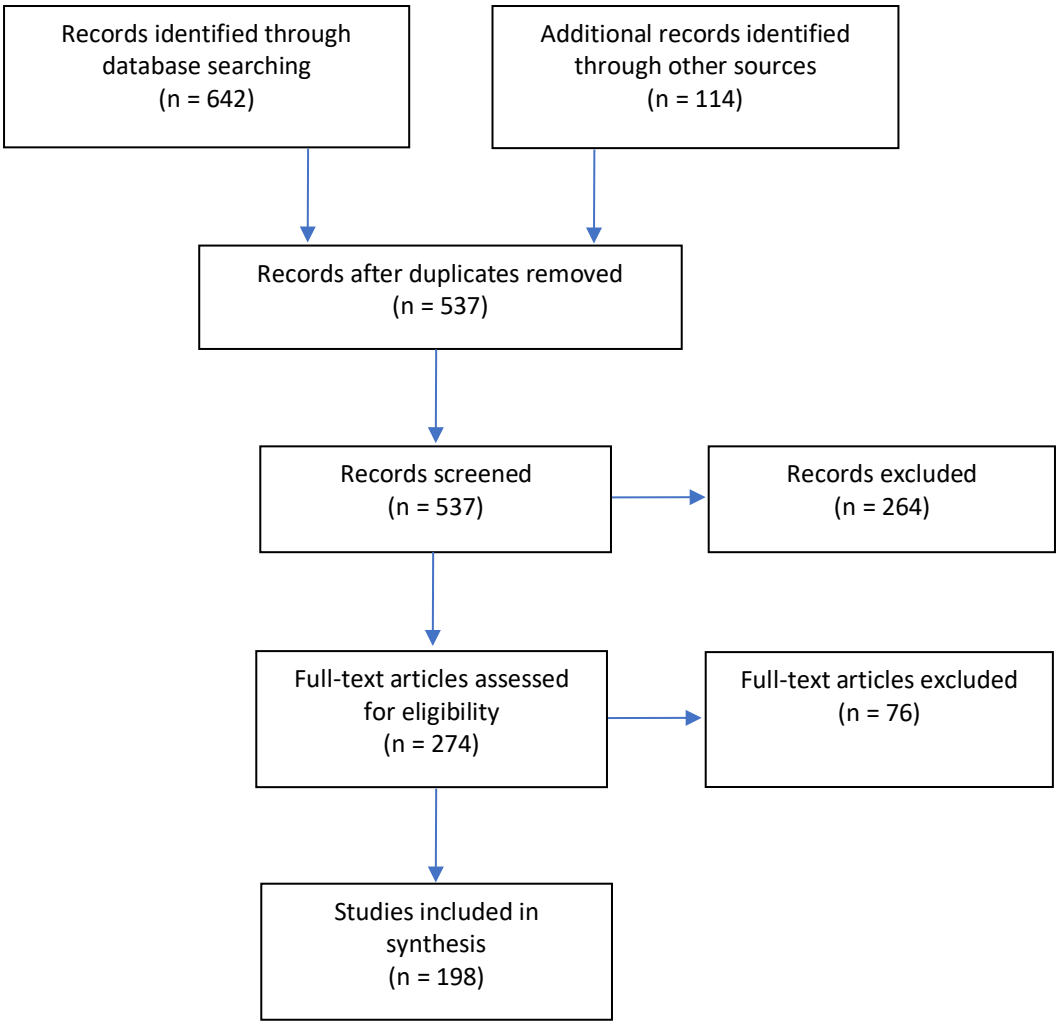

Figure 2. PRISMA Flow Diagram for Studies Selection

3.2.4 Data Charting

The data extraction form (see Table 4) is designed to provide a solid structure for data charting. The descriptive key elements and characteristics of included studies are collected such as general citation information (title, authors, year, and study types), research methods, types of ICT, subjects, settings, regions, training needs and detailed information of the instruments used in the studies such as name, origin, and content of the surveys. Some of the categories are predefined by predictable elements, such as different research methods used in the studies, i.e., quantitative research, qualitative research, and mixed methods research. The extracted information provides an overall perspective on the themes emerging from the selected studies relating to the research questions. A brief summary of the frequency and percentage of literature descriptors of included studies is provided in Table 5.

ID	
Title	
Authors	
Year	
Study Types	Journal Thesis Proceedings
Topic Categories	

Research Methods	Mixed Methods Quantitative Research Qualitative Research
Types of ICT	General
Subjects	
Settings	Pre-school Primary School Secondary School Higher Education
Regions	
Surveys	(Name, Origin, Content)
Qualitative	Compound Interview/Focus Group Others
Training Needs	Yes No
Demographic Information	Yes No
Memo	

Table 4. Data Extraction Form

Variables and Factors	Frequency	Percentage
Study Types		
Journal	160	80.8%
Proceedings	8	4.0%
Thesis	29	14.6%
Manuscript	1	0.5%
Topic Categories		
ICT Beliefs	104	53%
Teacher ICT Training Program	35	18%
Technology Competence and Literacy	21	11%
ICT Beliefs Comparison	10	5%
Relationship Studies	14	7%
ICT Beliefs Modeling	8	4%
Perception of ICT Based Teaching & Learning	6	3%
Research Methods		
Mixed	48	24%
Quantitative	122	62%
Qualitative	28	14%
Types of ICT		
General	109	55.1%
Computer [a]	39	19.7%
Internet	13	6.6%
Digital Storytelling	8	4.0%
Wiki/Blog	4	2.0%
Portable Devices [b]	4	2.0%
Web 2.0	3	1.5%
Others [c]	18	9.1%
Subject of the Teaching		
Unspecified	80	40.4%
Mixed	32	16.2%
Science	24	12.1%
Math	18	9.1%
Language	18	9.1%
Sports	7	3.5%
Computer	4	2.0%
Chemistry	3	1.5%
Biology	2	1.0%
Social Studies	2	1.0%
Health	2	1.0%

Physics	2	1.0%
Art	1	0.5%
STEM	1	0.5%
Geography	1	0.5%
Special Education	1	0.5%
Settings		
Pre-school	7	4%
Primary School	33	17%
Secondary School	11	6%
Mixed	32	16%
Unspecified	115	58%
Regions of Study		
Turkey	68	N/A [e]
United States	55	N/A
Singapore	13	N/A
China	10	N/A
Australia	9	N/A
Malaysia	6	N/A
United Kingdom	5	N/A
Others [d]	37	N/A
Training Needs		
Yes	71	36%
No	127	64%
Demographic Information		
Yes	107	54%
No	91	46%

[a] Computer included: Computer Programming, Computer Program, Computer Games, Computer Generated Art Imagery.
[b] Portable Devices included: Tablets, iPad, PDA, and Handheld Technology.
[c] Other types of ICT included: Science Lab, E-Picture Books, Online Discussion Board, e-Portfolios, Drawing, E-health, Social Media, Graphing Calculator, VBL (video-based case learning), Online Technologies, Dynamic Visualization, Audio-visual Technology, Slides, Mixed (E-book, Tablet PC, and Interactive Whiteboard), WebQuests, Computing Technologies, Digital Text, and Website.
[d] Other countries included: Belgium, Canada, Cyprus, Germany, Ghana, Greece, Indonesia, Iran, Israel, Kuwait, Morocco, Norway, Portugal, Romania, Rome, Saudi Arabia, Serbia, South Africa, South Korea, Spain, Sweden, Swiss, Tanzania, Thailand, Uganda, United Arab Emirates, and Yemen.
[e] Not Applicable in percentage counting because some studies included multiple regions.

Table 5. Frequency and Percentage of Literature Descriptors

3.2.5 Data Synthesis

The final stage of this scoping review was to synthesize, and report findings based on the research questions. Having a plan for data extraction and focusing on the descriptive nature of the studies in the charting stage enabled a straightforward way of describing the literature by creating the prior established categories and subcategories. The purpose of this final stage includes narrative synthesis and the interpretation of the findings.

3.3 Findings

3.3.1 Overview

The initial search yield 756 studies but then has been reduced to a total of 198 studies using inclusion and exclusion criteria to refine the selection of included studies in the final synthesis. The included studies are generally from four different sources: journal articles, conference proceedings, theses, and other manuscripts. The charting has revealed that seven different topic categories have been identified from the included studies and the majority of the studies are about ICT beliefs in general (n=104). Other types of topics with regard to ICT beliefs are teacher ICT training programmes (n=35), technology competence and literacy (n=21), comparison of ICT beliefs (n=10), relationship

studies (n=14) and the perceptions of ICT-based teaching and learning (n=6). Nearly two thirds of the reviewed studies have employed quantitative methods whereas 24% and 14% of the studies have adopted mixed methods and qualitative methods.

The majority types of the ICT described in the studies is ICT in general (not specifying one particular type of ICT tool), followed by computers (n=39), Internet (n=13), digital storytelling (n=8), wiki/blog (n=4), portable devices (n=4), web 2.0 technologies (n=3), and other types of technologies (n=18). The teaching subject of pre-service teachers involved is not specified or mentioned in some studies, whereas nearly 60% of the studies have reported the teaching subject of the participants. Also, most of the studies have not provided the settings or the level of teaching of the pre-service teachers, but for those studies which have identified the settings, primary school and secondary school settings take up to one fifth. Only seven studies included in the review on empirical studies of the pre-service teachers are in pre-school.

In addition, the included sources are authored form 34 different countries, which geographically reflects that Turkey (n=68) and the United States (n=55) have shown more state of interest in pre-service ICT beliefs, followed by Singapore (n=13), China (n=10), Australia (n=9), Malaysia (n=6), United Kingdom (n=5) and other countries (n=37). Surprisingly, more than a third of the studies have mentioned training needs in the discussion, and over half of the studies have collected demographic information of participants. More information in terms of topic categories and research methods in the included studies would be provided in the next section. Given the large number of studies included in the review and for the purpose of citation manageability, no more than six citations in a row are cited in the examples to answer the proposed research questions.

3.3.2 Review Question 1

The contribution to review question 1 comes in the form of extracted information of included studies relating to the seven themes identified, namely, ICT beliefs in general, teacher ICT training program, technology competence and literacy, ICT beliefs comparison, relationship studies, and the perception of ICT-based teaching and learning. These seven themes represent the most discussed issues about ICT beliefs of pre-service teachers. The most frequently noted theme is that of the studies on the description of pre-service teachers' ICT beliefs in general (e.g., Beacham & McIntosh, 2014; Fluck & Dowden, 2013; Gyamfi, 2017; Hazzan, 2002; Teo, 2008; Q. Zhou, Zhao, Hu, Liu, & Xing, 2010), and other most frequent noted topic is the measurement of pre-service teachers' ICT beliefs in teacher ICT training program (e.g., Akkaya, 2016; Hismanoglu, 2012a; Karatas, 2014; Tatar, 2013). Topics on technology competence and literacy are mainly focused on the confidence, self-efficacy of pre-service teachers' digital literacy and competence (e.g., Albion, Jamieson-Proctor, & Finger, 2011; Balcin, Ari, Erdogan, & Besoluk, 2014; Browne, 2009; Keser, Karaoglan Yilmaz, & Yilmaz, 2015; Topkaya, 2010; Yeung, Lim, Tay, Lam-Chiang, & Hui, 2012).

In addition, other topics like the comparison studies are mainly focused on the difference of ICT beliefs of pre-service teachers from different regions or departments (S. Can & Uzunboylu, 2010; C. S. Chai, Hong, & Teo, 2009; Efe, Efe, & Yücel, 2016), and on the comparison between in-service teachers and pre-service teachers' ICT beliefs (Best & Tidwell, 2002; Gomez, Garrett, & Kouzekanani, 2016; Teclehaimanot, Mentzer, & Hickman, 2011). For relationship

studies, relationships between confidence and attitude towards e-health technology (Çiftci & Aladag, 2018) and relationships between pre-service primary school teachers' Attitude Scale for Digital Technology levels and Digital Citizenship Scale levels (Lam, Nguyen, Lowe, Nagarajan, & Lincoln, 2014) are examined. The literature about perceptions of ICT-based learning and teaching has reflected pre-service teachers' attitudes towards the use of ICT tools in a certain way (Barak, 2014; Basoz, Cubukcu, Laborda, Ozdamli, & Maasoglu, 2014; Cobanoglu et al., 2009; Kuo, 2008; Onder, Celik, Silay, Karahoca, & Kanbul, 2011; Yagci, Sirakaya, Ozudogru, Iaman, & Eskicumali, 2015).

3.3.3 Review Question 2

The design of the included empirical studies in the scoping review has mostly relied on the previous research and is therefore progressive or cumulative in nature. The most commonly used two kinds of instruments of quantitative data collection in the selected studies are the Technology Attitude Scale (e.g., Baz, 2016; Findikoglu, Alci, & Karatas, 2015; Giles & Tyler-Wood, 2016; Ipek, Berigel, & Albayrak, 2007; Yucel, Kocak, Uzunboylu, & Cavus, 2009) and the Computer Attitude Scale (e.g. Bolandifar & Noordin, 2015; Suleyman Can, 2015; S. Can & Uzunboylu, 2010; DuBay & Gredler, 2001; Duru, Peker, & Birgin, 2012; C.-H. Huang & McNeil, 2003). Other surveys in the selected studies have adopted the Attitude towards Educational Technology Scale (Efe et al., 2016; Kabadayi, 2006), Technology Perception Scale (Incik & Akay, 2017; Kobak & Taskin, 2012; Koksal, Yaman, & Saka, 2016; Tatar, 2013; Varol, 2015), Technology Acceptance Scale (Baturay, Gökçearslan, & Ke, 2017), Attitude Scale for Digital Technology (Çiftci & Aladag, 2018), Attitude Scale towards the ICT (Yağci, 2016), Teacher Perception of New Technology (Redman, Trapani, & Australian Association for Research in, 2012), Technology Disposition Scale for Teacher Education Students (E. J. Jung & Rhodes, 2004; Karr & Steckelberg, 2014), Internet Attitude Scale (Bolandifar & Noordin, 2015; Gungoren & Horzum, 2015; Kaya & Durmus, 2011; Lin & Liang, 2012; Oral, 2008), Web 2.0 Attitude Scale (Kobak & Taskin, 2012), TPACK Confidence Scale (Keser et al., 2015; Sancar-Tokmak & Yanpar-Yelken, 2015; Scherer, Tondeur, Siddiq, & Baran, 2018; Varol, 2015), or Attitude Scale towards Instructional Technologies (Işikgöz, 2016).

Most of the studies have adopted or modified the categories of the Technology Acceptance Model (TAM) into the scales, for example, Teo (2010) has extended the TAM model in the study by including perceived usefulness (PU), perceived ease of use (PEU), subjective norm (SN), facilitating conditions (FC), technological complexity (TC), and attitudes towards computer use (ATCU). The most commonly used original sources of the surveys adopted in the selected studies can be tracked from the citations on previous studies (Kinzie, Delcourt, & Powers, 1994; Loyd & Gressard, 1984; Schmidt et al., 2009; Teo, Lee, & Chai, 2008; Tınmaz, 2004b; Tsai, Lin, & Tsai, 2001; Yavuz, 2005), other common original sources of surveys can be tracked as well (Hills & Argyle, 2003; Selwyn, 1997; Teo, 2009, 2010; L. Wang, Ertmer, & Newby, 2004).

As for qualitative methods, interviews or focus groups (e.g. Bansilal, 2015; Baz, 2016; Ching Sing Chai, Wong, & Teo, 2011; Goktas & Demirel, 2012; Gunes & Bahcivan, 2018; Smarkola, 2008), open-ended questions (e.g. Allsopp, McHatton, & Cranston-Gingras, 2009; Incik & Akay, 2017; Koc & Bakir, 2010; Sabiescu et al., 2013; Yeung et al., 2012; Zambak & Tyminski, 2017), observation (e.g., Constantin & Sgem, 2014; Lu, 2005; Sabiescu et al., 2013; Sancar-Tokmak & Yanpar-Yelken, 2015; Zambak & Tyminski, 2017), and written responses (e.g. Angeli, 2004; Funkhouser &

Mouza, 2013; Greene-Clemons, 2016; Prasojo et al., 2017; Rehmat & Bailey, 2014; Tiba, Condy, Chigona, & Tunjera, 2015) are the top four approaches for qualitative data collection. Other approaches, such as portfolios, lesson plans, digital stories, micro-teaching, discussion, blogging, metaphors, artifacts, drawing, visual associated activity, journals, and document review are also included in the qualitative studies.

Direct questions in interviews and focus groups are mostly used and focused on the experience of perceiving and use of the technology in teaching, for example, Al-Awidi and Alghazo (2012) have used four categories of experience to elicit pre-service teachers' ICT beliefs: 1) mastery experience: ''what experiences affected your choice and decision to integrate technology in your teaching?''; 2) vicarious experience: ''Was there anyone who had an effect on your beliefs to integrate technology in your teaching?'' ''How did those people affected you?'' 3) social persuasion: ''How have people around you encouraged you to utilize technology?'' 4) psychological and emotional states: ''How do you feel when you integrate technology in your teaching?''.

3.4 Discussion

3.4.1 Review Outcome

This scoping review has employed a systematic approach to identify studies dealing with pre-service teachers' ICT beliefs. The approach of the review is underpinned and followed by the PRISMA statement (Moher, Liberati, Tetzlaff, Altman, & 2009), and the framework developed by Arksey and O'Malley (2005). By uncovering a considerable volume of literature, outlining a framework of current existing literature, and extracting the key data and cataloged database of the literature in a comprehensive manner, it has revealed the crucial factors in terms of measuring pre-service teachers' ICT beliefs, explored unresolved issues with the current literature of pre-service teachers' beliefs of different technologies, provided clear directions for the development of further educational research and practice. Two research questions were answered by synthesizing the key data extracted from the selected studies in terms of the topic categories and the methodologies of the literature on pre-service teachers' ICT beliefs. These have added rigor to the scoping review process and thus serve as strengths. It also contributes to the methodological aspect of conducting the scoping review systematically by providing and expatiating the approaches adopted in the reports of research, which could help move the relevant research field forward.

Seven themes are categorized in this scoping review, and the majority of the studies are focused on the perception of ICT in general or on one specific ICT tool. Very few of the studies reviewed have focused on the difference in ICT beliefs at a regional or national level, also the perception of multiple technologies. Even though a few studies are relating to the pre-service teachers' beliefs on trending technologies, such as portable devices, there is no study regarding the perception of the innovative and cutting-edge technologies from pre-service teachers, such as wearable devices, artificial intelligence, virtual reality, augmented reality and so on. Given the evidence that a large portion of the reviewed studies have not specified the subjects or levels of the pre-service teachers for their future teaching, it is recommended that the researchers should provide the basic demographic information to a greater extent to provide future readers and researchers the opportunity to understand the background of the research settings. Potential ICT training needs should be discussed for future studies to develop relevant professional training

programs for pre-service teachers in order to move forward and make a difference in this research field. It is suggested that future research on pre-service teachers' ICT beliefs could be followed on the cutting-edge technologies, by providing comprehensive demographic information and research background, and contributing the analysis of corresponding training needs of these ICT tools.

3.4.2 Challenges and Limitations

Although in this study the scoping review is used for a rapid method for mapping and synthesizing existing literature in a particular topic area, and identifying the knowledge gaps for future research, the researcher still encountered challenges in terms of the methodology itself and the process of conducting the review. The scoping review is considered as a rapid review method to synthesize knowledge in a systematic but a simplified manner (Tricco et al., 2015), but it is by no means a rapid process (Brien, Lorenzetti, Lewis, Kennedy, & Ghali, 2010). After developing a systematic search strategy, obtaining a comprehensive entry of existing literature, selecting studies using inclusion and exclusion criteria, the data extraction and charting process were demanding. It was not feasible to extract data and chart studies in depth while still maintaining the perspective of the breadth of the scoping. And it was hard to balance between the breadth of the literature and in-depth synthesis on specific topic areas by reading the papers on scoping review. Thus, in this scoping review, by serving its purpose of finding the knowledge gap for further research in the doctoral study, an optimized balance was performed but it took a longer time than expected to complete the process.

The scoping review shares part of the process of systematic review methodology, but it is not intended to assess the quality of the scoped literature. It was difficult to identify the lack of literature without assessing the quality of the selected studies since the existing literature does not necessarily provide sufficient evidence for the robustness and relevance to the local context (Grant & Booth, 2009). Furthermore, a lack of quality control but sharing the characteristics of systematic review is difficult to reconcile and it can create confusion on the understanding and acceptance of labeling the review category based on numerous types of rapid review methods. For instance, by evaluating the purpose, nature, and the process of the review, this piece of review could either be labeled as a mapping review (Grant & Booth, 2009) or a scoping review (Arksey & O'Malley, 2005). Therefore, after the completion of this scoping review, it is imperative to reach a consensus and advance current guidelines for scoping reviews and mapping reviews, which could improve the transparency and acceptance in rapid review methods.

Apart from the experience of methodological challenges, a number of operational limitations also emerged and should be explicitly noted. A broader search may lead to the identification of further studies. After the screening process, the researcher realized that the string "future teacher*" was not included in the search strategy. In that case, some studies may have been ignored and not included in the screening process. However, surprisingly the result of search entries showed several studies containing the keywords "future teacher*", so it was unclear that whether some relevant studies were included or not because of the missing search string. In addition, more studies may have been identified if the keywords were searched in the abstract instead of in the title merely. The process of obtaining full text was quite slow, either no copies could be traced, or the authors would never respond back to the

researcher. It was also a draining process to index all the pdf documents to the reference list in Endnote since the function of “Find Full Text” in Endnote is not satisfying. Besides, some duplications were hard to discover by software or manually; for example, the same published study can be traced from different sources, but they were hard to be identified as duplicates since the deposit of the publication was different, i.e., journal name and/or page number, but with the same content inside.

The data extraction process involves some judgment rather than being a purely mechanical summary. For example, some authors did not refer to “demographic information was collected” but they nevertheless listed the detailed information of participants, such as the subjects, teaching grade, age, and gender. Although it was a major advantage in the process of summarizing the topics and methodologies in the included studies, other attributions, such as the sample size of the data, strategies of data analysis, and findings could also be considered and cataloged more extensively in the data extraction and charting process based on the results and nature of the empirical research. Last but not the least, since the completeness of the scoping review is determined by time constraints, it would be out of date shortly after completion. However, the task of updating a comprehensive scoping review studies is huge, and it cannot be undertaken without “the perpetual availability of ongoing resources and personnel” (Brien et al., 2010, p. 10). These limitations are not detrimental to the report presented in this review but do indicate further considerations for interpreting the findings and planning the research in the future.

3.4.3 Further Steps

This scoping review has produced a comprehensive literature database from a large volume of literature pertaining to pre-service teachers’ ICT beliefs. It has also identified a number of research gaps and notions in the literature that need to be addressed in future research, and it enables future researchers to carry out more in-depth reviews, such as systematic review, based on the current literature mapping. The resulting repository in this review could provide preliminary information and may be useful to researchers interested in the topic of pre-service teachers’ ICT beliefs. Using the insights gleaned from this scoping review, a systematic review on the category of ICT beliefs in general and an empirical study where the methodology could be referenced and guided by the findings synthesized in the scoping review, which would be developed and conducted in the later stage of the doctoral research.

4. Systematic Review: Pre-service Teachers' ICT Beliefs

4.1 Introduction

The previous chapter employed a scoping review to explore the ICT beliefs of pre-service teachers. In this chapter, a systematic review is employed to further examine the ICT beliefs of pre-service teachers. These two pieces of work are similar since they both follow a structured process, but they are performed and conducted for different reasons and with key methodological differences (Arksey & O'Malley, 2005; Colquhoun et al., 2014a; Levac, Colquhoun, & O'Brien, 2010; Peters et al., 2015). The evidence synthesis in the scoping review in the previous chapter can offer an ideal approach to discover the scope or coverage of the literature in a specific topic area, identify the availability of literatures and studies in the field, to indicate an either broad or detailed overview on the map of evidence, and underpin a preliminary evidence-based scoping stage for systematic review (S. Anderson, Allen, Peckham, & Goodwin, 2008; Arksey & O'Malley, 2005; Munn et al., 2018). The systematic review in this chapter aims to employ a more rigorous and more detailed method with a predefined approach; it also aims to establish the quality of gathered evidence, to synthesize international evidence in relation to particular questions, and to produce a more reliable finding (Aromataris & Pearson, 2014; Higgins et al., 2019; Liberati et al., 2009; Munn et al., 2018; Munn, Porritt, Lockwood, Aromataris, & Pearson, 2014). Thus, the combination of the scoping review and the systematic review in this thesis covers both the breadth and depth of the evidence of pre-service teachers' ICT beliefs. The review protocol in the next section was the plan of the systematic review and written prospectively, and the deviations of the protocol will be discussed in a later section.

4.2 Review Protocol

4.2.1 Review Background

Information and Communication Technology (ICT) can support, extend, or transform teaching in terms of the curriculum, teaching purposes and students' needs (Protopsaltis, Goodwyn, & Fuller, 2009). The successful implementation of technology in the classrooms has been the focus in the field of teacher education (Y. Lee & Lee, 2014). However, Ertmer (1999) has stated two barriers in terms of teachers implementing technology in the classroom. The first-order barriers "extrinsic to teachers" (p. 48), such as resources, support, and training, while the second order, perceived to pose a greater challenge (Newhouse, 2001), "intrinsic to teachers" (p. 48) include their beliefs and confidence of the technology towards teaching and students' learning process. Studies (e.g., Inan & Lowther, 2010; Miranda & Russell, 2012) have shown that teachers are more likely to implement technology in their teaching when they believe that the ICT use would have a positive influence on students' learning outcomes. Additionally, Tsai and Chai (2012) have proposed an additional, the third-order barrier related to teachers' "design thinking" (p.1058). Teachers may need to maximize their potential in the presence of first-order barriers, and then try to think about how to overcome the second and the third-order barriers (Makki, O'Neal, Cotten, & Rikard, 2018) in relation to ICT.

A systematic review of pre-service teachers' ICT beliefs has not yet been conducted, which will contribute the original research in the educational field in relation to this topic. This systematic review will provide an insightful

view of teachers' ICT beliefs and perceptions in general. In terms of the implications for Education Department in China, this research could contribute positively to the decision-making process of the Education Informatization policy development.

4.2.2 Review Questions

The primary goal of the systematic review is to identify studies which examine the influence of pre-service teachers' ICT beliefs and perceptions of their own and their students' ICT use in the classroom. In order to achieve the research goal and guide the empirical study in the later stage of the research, the final studies selected and included in the systematic review will be coded to various themes to answer four main research questions:

1) What are the categories and descriptions of ICT beliefs among pre-service teachers?
2) What are the reported factors that affect their adoption of various ICT tools in their teaching and how?
3) Is there any variation of ICT beliefs across countries such as gender, culture, country development stage, technology adoption stage, or pedagogical context differences?
4) Is there any difference of pre-service teachers' ICT beliefs according to the various subjects that they teach?

An extra research question will be answered if the included studies have mentioned about the needs of ICT training for pre-service teachers:

5) What is evidence regarding the ICT training needs of pre-service teachers when investigating their ICT beliefs and perceptions?

4.2.3 Search Procedure

By using various combinations and synonyms of key words and cognate terms derived from the research questions, the preliminary searches should identify existing studies and estimate the potential volume of relevant literature. It is necessary to generate a sophisticated search strategy in consultation with experts or university librarians and by checking the homogeneous research strings identified in the trial research, which could be a list of cognates, synonyms, acronyms, alternative spellings with the use of truncation and wildcards. As for any grey (unpublished or informal) literature, contacting experts and researchers working in relevant area would be an option to access these documents as well as systematic web searching. Though finding all the applicable studies maybe one of the strenuous and most time-consuming parts of a systematic review, documenting them also matters. Reference managing tools, such as Endnote X8, can create a "virtual filing cabinet" (Fink, 2005, p. 40) to store the research documents as well as keep records of reference citation mechanism (Hart, 1998). The search strings will be based on relevant key words and their derivatives and the search terms will be divided to English version and Chinese version (see Table 6).

Search Strings in English	Search Strings in Chinese
"ICT" OR "Information and Communication Technology" OR "technology" OR "computer*" OR "Digital" OR "IT" OR "Information Technology" OR "Internet" AND "Perception*" OR "Belief*" OR "Attitude*" OR "Confidence" AND	"ICT" OR "信息技术" OR "信息与通讯技术" OR "多媒体" OR "计算机" OR "科技" OR "网络" AND "师范生" OR "师范教育" OR "职前教师" AND

"teacher education" OR "pre-service education" OR "student teacher" OR "pre-service teacher" OR "prospective teacher"	"观" OR "观念" OR "理念" OR "价值取向" OR "态度" OR "信念"

Table 6. Search Strings in Systematic Review

Journal papers, conference proceedings and dissertations would be searched by the search engines and databases below (Table 7):

Global Database	Chinese Database Only
- Web of Science - Scopus - ERIC - JSTOR - British Education Index - ScienceDirect - ProQuest Dissertation - Google Scholar (Both in English and Chinese)	- CNKI (China National Knowledge Infrastructure, www.cnki.net) - WanFang Data (www.wanfangdata.com) - CQVIP (www.cqvip.com) - Baidu Xueshu (xueshu.baidu.com) - Hong Kong Macau Periodicals Network (hkmpnpub.lib.cuhk.edu.hk) - EdUHK Library (julac.hosted.exlibrisgroup.com/primo-explore/search?sortby=rank&vid=EDUHK&lang=en_US) - Airiti Library (www.airitilibrary.cn and www.airitilibrary.com) - NDLTD (National Digital Library of Thesis and Dissertations in Taiwan, ndltd.ncl.edu.tw)

Table 7. Search Engines and Databases in Systematic Review

4.2.4 Inclusion and Exclusion Criteria

1) Types of study designs: empirical research design reporting quantitative or qualitative data about pre-service teacher ICT beliefs (studies relating to teachers' ICT beliefs are mostly survey / questionnaire-based, but the in-depth interview research design is welcomed in the synthesis).

2) Types of participants: all disciplinary pre-service teachers in the universities/colleges or equivalent level (pre-service teachers or students teachers attending university/college are normally enrolled in BA, BS, PGDE, PGCE, or postgraduate degrees).

3) Studies concern pre-service teachers' ICT beliefs regarding the use, integration, or adoption of ICT in the classroom (the measurement of the pre-service teachers' ICT beliefs need to have implications in the teaching practicum).

4) Studies published or unpublished in the public domain from 2001 to 2018 (in the 21st century).

5) Studies written in English or Chinese (including Simplified Chinese or Traditional Chinese) for the better understanding of variation of ICT beliefs across countries.

4.2.5 Screening

The screening of the studies will be conducted in two stages using pre-established inclusion and exclusion criteria: 1) title and abstract screening, and 2) full-text screening. As a single researcher, the included and excluded papers will be checked and discussed with second reviewer, or after the initial screening, apply a test-retest and re-evaluate a random sample of the primary studies to check the consistency of the inclusion and exclusion decisions (Keele, 2007). It is convenient to share the entire EndNote library with my supervisor for the convenience of double-checking of the literatures for intra-reviewer and inter-reviewer reliability including references, attachments, and annotations online with unlimited cloud storage by using Endnote collaboration functions. Other sharing methods could be using outputs from this via Microsoft SharePoint, Microsoft OneDrive, Google Drive or Dropbox.

4.2.6 Data Extraction

Research studies that have been identified as meeting the inclusion and exclusion criteria will be reviewed systematically and extracted the relevant key information. A data extraction form will be designed and adopted under current guidelines (e.g., EPPI, 2003; Keele, 2007; Okoli & Schabram, 2010; Sayfouri, 2014). Critical elements of the studies will be summarized in data extraction form to create a systematic mapping of the research, including the study ID, authors, title, source, language, study aims and rationale, study research questions, research country, research design, sampling strategy, recruitment and ethical issues, data collection method, pre-service teacher characteristics, data analysis method, results, as well as implications for policy, practice, and research. The questionnaire for included studies sometimes differs from the form of the question and the numbers of the question; therefore, questions that are most similar will be combined into categories. The interview questions and responses will also be categorized according to themes. EPPI Guidelines for extracting data and quality assessing primary studies in educational research Version 0.97 will be modified and adapted in data extraction. Key information will be extracted to the Data Extraction Form (See Table 8).

ID	
Title	
Authors	
Year	
Study Sources	Journal Thesis Proceedings
Language	English Chinese
Research Methods	Mixed Methods Quantitative Research Qualitative Research
Research Design	Cross-sectional Design
Research Aims	
Research Questions	
Regions	
Subjects	
Settings	Pre-school Primary School Secondary School Higher Education Mixed Settings
Sample Size (n=)	
Sampling Strategy	
Ethical Considerations	Yes/No
Data Collection Instruments	Surveys (Name, Origin, Content) Interview/Focus Group
Data Analysis	
Findings	
Implications	
Memo	

Table 8. Data Extraction Form

4.2.7 Quality Assessment

The quality of the studies will be analyzed using Weight of Evidence Framework (Gough, 2007). Four dimensions of Weight of Evidence Framework will be included in the quality assessment: 1) coherence and integrity of the

evidence, i.e., transparency, accuracy, accessibility, and specificity, 2) the fitness of the research design and analysis for answering the review questions, i.e., purposivity, 3) the relevance of the focus for answering the review questions, i.e., utility and propriety, and 4) the overall contribution of a study for answering the review questions.

4.2.8 Data Synthesis

In this systematic review, a relatively new approach will be used for the data analysis and synthesis. The combined synthesis by integration and by explanation not only involves the recognition of a hierarchy of evidence from quantitative research, but also identifies the interpretation and explanation of the social phenomenon in context (Rousseau, Manning, & Denyer, 2008). Data managing tools will be used in the data analysis stage, such as the EPPI-Reviewer 4 gateway, and RevMan 5. Also D. Lee, Kang, Mitra, Giles, and On (2007) provide useful information on triangulation of quantitative and qualitative synthesis using electronic tools.

4.3 Methods

4.3.1 Deviations from the Protocol

Some main difference between the review process and the protocol must be noted explicitly. Due to the massive workload of this systematic review and lack of experience of conducting a systematic review, the sphere of the review was reduced and limited to a manageable expanse. Although the goal of the research remains the same, the research questions have been adjusted to three domains based on the needs of the empirical research in the later stage: 1) What are the reported factors that affect their adoption of various ICT tools in their teaching and how? 2) Is there any variation of ICT beliefs across countries such as gender, subjects, culture, country development stage, technology adoption stage, or pedagogical context differences? 3) What is evidence regarding the ICT training needs of pre-service teachers when investigating their ICT beliefs and perceptions? The altered research questions are more compact for this systematic review since the first original research question was partially answered in the scoping review in the previous chapter, and the combination of the third and fourth original research questions could produce more efficient synthesis of included studies.

Despite the fact that the scoping review in the previous chapter has adopted the similar search strategies, the systematic review retained the same search strategy in English search strings and databases, and continues to work on the review based on the result of the scoping review, but eliminates all the search procedures on Chinese search strings and databases for the purpose of the continuity of previous scoping review (to achieve deeper analysis and synthesis on studies written in English) and the disconcerting workload of the remaining research for this EdD thesis.

In terms of the study selection process, an additional exclusion criterion has affixed to the Inclusion and Exclusion Criteria: 6) Any studies that fall into the topic categories in previous scoping review other than “ICT Beliefs” will be excluded. This exclusion criterion could help the reviewer to quickly identify the potential scope of the studies and take advantage of the result of the scoping review in the previous chapter since they share the similar search strategies in two different reviews. In the screening process, the researcher was the only reviewer due to the gap of the time span during and between the research conduction process and the writing process, as well as the limited time to proceed the intra-reviewer and inter-reviewer reliability after the review process.

As for the deviation of data extraction and data synthesis, the element of Language was deleted in the Data Extraction Form due to the alteration of the search strategies, the interview questions and responses will no longer be categorized according to themes because of limited qualitative data in the included studies, and the synthesis of the data would focus on answering the three altered review questions without further identifications and explanation of the social phenomenon in context which would be mentioned in the later stage of empirical research. Overall, Table 9 displays the summary of the deviations from the protocol.

4.3.2 Selection of Studies

Since the selection of studies in this systematic review is based on the result of the scoping review in the previous chapter, the process of search strategies, abstract screening and full-text screening shared the same procedure. The initial search and additional search resulted in 756 hits in the following database and sources: Scopus, Web of Science, ERIC, JSTOR, ScienceDirect, British Education Index, ProQuest Dissertation, Google Scholar, Research Gate, and other sources on the web. 219 duplicates were removed in the initial result; thus 537 studies were included in the title and abstract screening. After excluded 264 studies because of lack of relevance, 274 studies were screened at full text level. After the full text screening, 198 studies were included in the corpus of the scoping review.

Based on the result of the scoping review, the 104 studies in the category of ICT Beliefs are included in the further full-text screening process. 79 studies were excluded after the further full-text screening resulting to 25 eligible studies for systematic review inclusion. Thus, in this systematic review process, three levels of screening are performed, i.e., the title and abstract screening, the full text screening for scoping review, and full-text screening for systematic review. In retrospect, this scrutinized three level screening processes plus a scoping review based on the screened studies have increased the reliability of this systematic review. The flow diagram in Figure 3 provides details of the search and selection of studies.

4.3.3 Data Analysis and Data Synthesis

The data analysis was implemented in two stages: study description extraction in Microsoft Excel for Microsoft 356 (16.0) based on data extraction form from the protocol, and the coding process in NVivo 20 based on three review questions. The implemented structure of the data analysis is shown in Figure 4. The purpose of the study description extraction with three categories – general descriptions, methodology descriptions, and outcome descriptions – is to provide a comprehensive understanding on included studies, whereas the coding process aimed to assist giving an overview of the main findings of included studies and answering the following three review questions in this systematic review:

1) What are the variables of ICT beliefs measured in the studies such as gender, subjects, culture, country development stage, technology adoption stage, or pedagogical context differences?
2) What are the reported factors that affect their adoption of various ICT tools in the teaching and how?
3) What are the recommendations regarding the ICT training needs of pre-service teachers when investigating their ICT beliefs and perceptions?

Aggregative synthesis is adopted in the data synthesis process since the potential of qualitative evidence could potentially strengthen the effectiveness of the review (Harden & Thomas, 2010; Noyes, 2010). The mixed methods approach enables the synthesis process to utilize quite different types of data, such as the questionnaires data from quantitative studies, interview data from qualitative studies, or the various types of data from mixed-method studies (Thomas, O'Mara-Eves, Harden, & Newman, 2017). In this review, both quantitative data and qualitative data are considered to address the review questions, and the analysis is conducted by converting the statistical data to textual and coding the reported findings to bring different types of data together to answer the review questions.

Protocol Procedure	Deviations	Justification
Original Research Questions: 1) What are the categories and descriptions of ICT beliefs among pre-service teachers? 2) What are the reported factors that affect their adoption of various ICT tools in their teaching and how? 3) Is there any variation of ICT beliefs across countries such as gender, culture, country development stage, technology adoption stage, or pedagogical context differences? 4) Is there any difference of pre-service teachers' ICT beliefs according to the various subjects that they teach? An extra research question will be answered if the included studies have mentioned about the needs of ICT training for pre-service teachers: 5) What is evidence regarding the ICT training needs of pre-service teachers when investigating their ICT beliefs and perceptions?	Altered Research Questions: 1) What are the variables of ICT beliefs measured in the studies such as gender, subjects, culture, country development stage, technology adoption stage, or pedagogical context differences? 2) What are the reported factors that affect their adoption of various ICT tools in their teaching and how? 3) What are the recommendations regarding the ICT training needs of pre-service teachers when investigating their ICT beliefs and perceptions?	The first original research question was partially answered in the scoping review in the previous chapter and the combination of the third and fourth original research questions could produce more efficient synthesis of included studies.
Original Search Strategies: Including the search strings and search database both in English and Chinese	Altered Search Strategies: Eliminating all the search procedures on Chinese search strings and databases	For the purpose of the continuity of previous scoping review (to achieve deeper analysis and synthesis on studies written in English) and disconcerting workload of the remaining research for doctoral thesis.
Original Study Selection Process: Including 5 inclusion and exclusion criteria and a second reviewer.	Altered Study Selection Process: An additional exclusion criterion has affixed to the Inclusion and Exclusion Criteria: 6) Any studies that fall into the topic categories in previous scoping review other than "ICT Beliefs" will be excluded. The researcher is the only reviewer in the screening process.	This exclusion criterion could help the reviewer to quickly identify the potential scope of the studies and take advantage of the result of the scoping review in the previous chapter since they share the similar search strategies in two different reviews. Due to the gap of the time span during and between the research conduction process and the writing process, as well as the limited time to proceed the intra-reviewer and inter-reviewer reliability after the review process.
Original Data Extraction and Data Synthesis Process: The element of Language is included in the Data Extraction Form. The interview questions and responses will also be categorized according to themes. The synthesis also identifies the interpretation and explanation of the social phenomenon in context.	Altered Data Extraction and Data Synthesis Process: The element of Language is deleted in the Data Extraction Form. The interview questions and responses will no longer be categorized according to themes. The synthesis of the data would focus on answering the three altered review questions without further identifications and explanation of the social phenomenon in context.	Due to the alteration of the search strategies, limited qualitative data in the included studies, and the considerations of the later stage of empirical research.

Table 9. Summary of Deviations from the Protocol

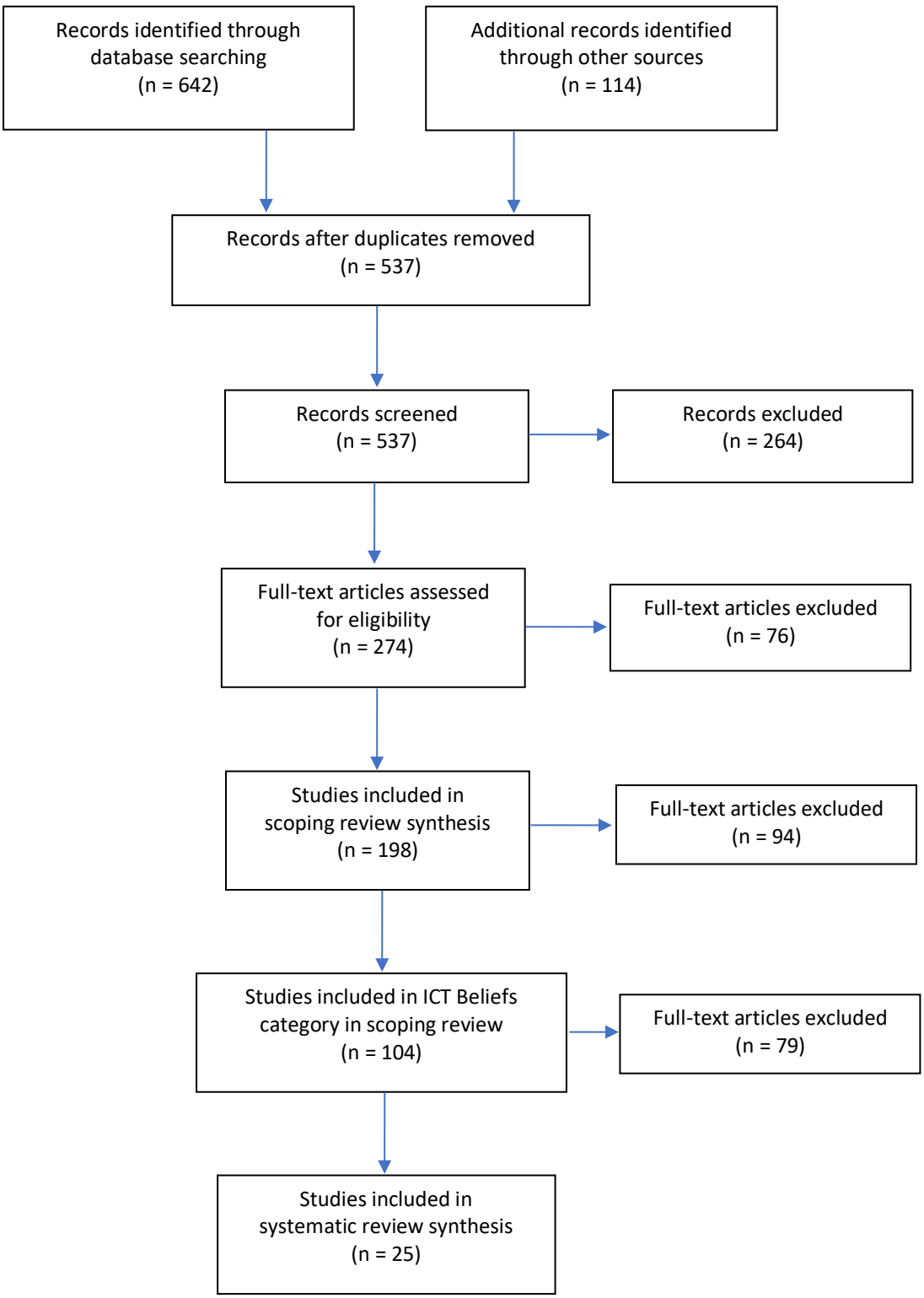

Figure 3. PRISMA Flow Diagram of the Selection of Studies

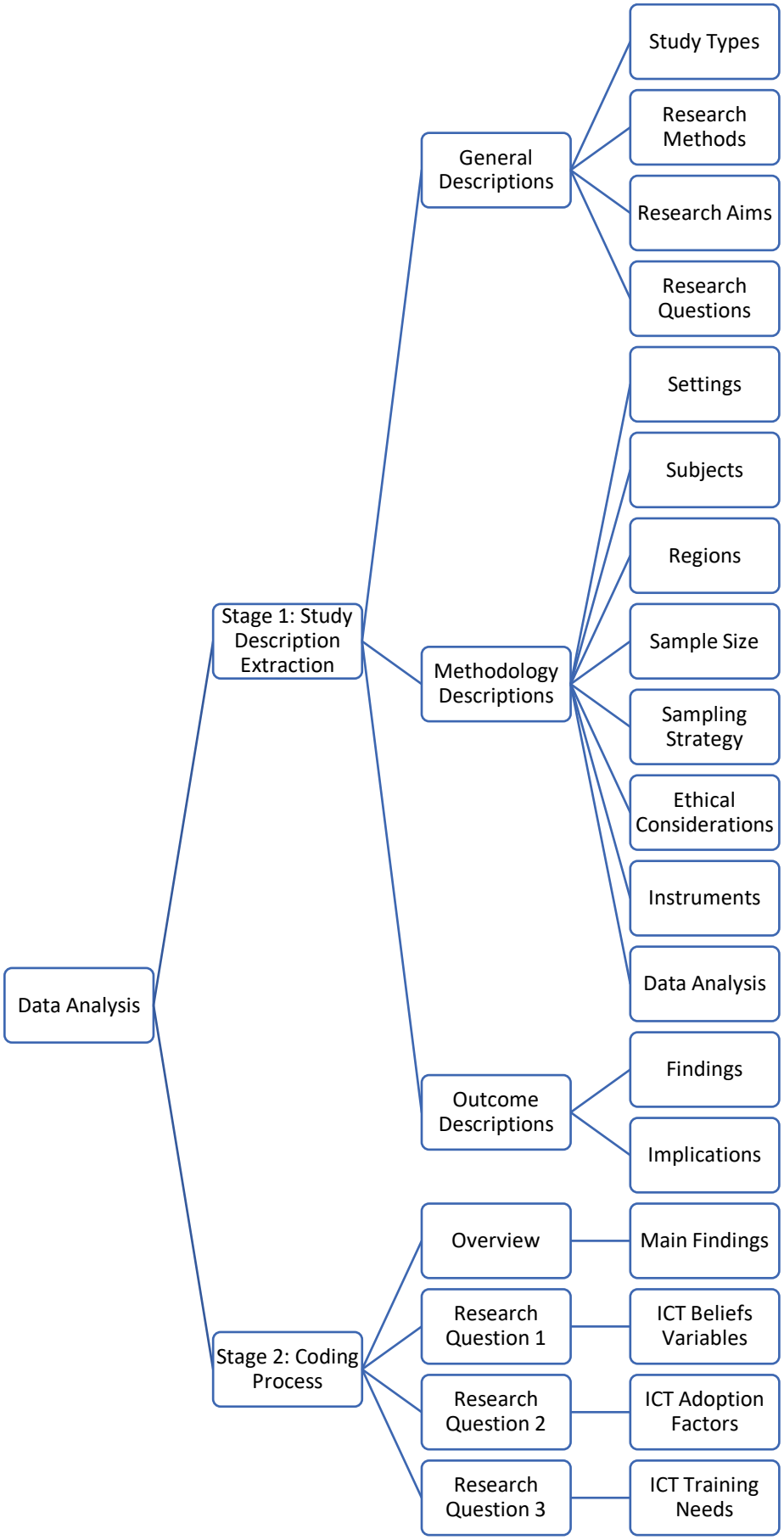

Figure 4. Data Analysis Implementation Stages and Categories

4.3.4 Quality Appraisal

Weight of Evidence A: Generic on quality of execution of study.	Transparency – clarity of purpose Accuracy – accurate Accessibility – understandable Specificity – method-specific quality
Weight of Evidence B: Review specific on appropriateness of method.	Purposivity- fit for purpose method
Weight of Evidence C: Review specific on focus / approach of study to review question	Utility – provides relevant answers Propriety – legal and ethical research
Weight of Evidence D: The extent that a study contributes evidence to answering a review question.	Combination of three sets of judgements

Table 10. Summary of Weight of Evidence Framework

The included studies were assessed using the Weight of Evidence Framework with four sets of judgements: Weight of Evidence A, Weight of Evidence B, Weight of Evidence C, and Weight of Evidence D. The summary of Weight of Evidence Framework on how to assess a study is shown in Table 10. Each judgement is assessed by three levels of scales, i.e., Low, Medium, and High. If a study is transparent, accurate, accessible and with method-specific quality, for example, the Weight of Evidence A would be assessed as High; if the study is partially fit for purpose method, such as non-randomized sampling strategy, small sample size, or any missing information on its research method, the Weight of Evidence B would be evaluated as Medium; if the study is unable to provide relevant answers to the research questions and relevant information on ethical consideration, the Weight of Evidence C would be marked as Low. Weight of Evidence D is the overall assessment of the study, and it is based on the scale of Weight of Evidence A, Weight of Evidence B, and Weight of Evidence C. For instance, if a study is rated High on Weight of Evidence A, Medium on Weight of Evidence B, and Medium on Weight of Evidence C, then the overall assessment of Weight of Evidence D would be Medium. The summary of quality assessment of included studies using Weight of Evidence Framework is demonstrated in Table 11. Also, the scale count and the bar chart of Weight of Evidence judgements are shown in Table 12 and Figure 5.

ID	Studies	WoE A	WoE B	WoE C	WoE D
1	Y. Akbulut, Odabasi, and Kuzu (2011)	High	High	Medium	High
2	Alblaihed (2016)	High	Medium	High	High
3	Alkan and Erdem (2010)	Medium	Low	Medium	Medium
4	Bansilal (2015)	Medium	Medium	Medium	Medium
5	Baz (2016)	Medium	Medium	High	Medium
6	Birkollu, Yucesoy, Baglama, and Kanbul (2017)	High	Medium	Medium	Medium
7	S. Can (2016)	Medium	Medium	High	Medium
8	Chisalita et al. (2012)	Medium	Low	Medium	Medium
9	Delaney et al. (2014)	Medium	Medium	Medium	Medium
10	Dogan, Yang, Majewski, De Alwis, and Karakirk (2011)	Medium	Medium	Medium	Medium
11	Eyyam et al. (2010)	Medium	Low	Medium	Medium
12	Gok and Erdogan (2010)	Medium	Medium	Medium	Medium
13	Gurcay, Wong, and Chai (2013)	High	Medium	High	High
14	Gyamfi (2017)	High	High	High	High
15	Hismanoglu (2012b)	High	Medium	Medium	Medium
16	Incik and Akay (2017)	High	Medium	Medium	Medium
17	E. J. Jung and Rhodes (2004)	High	Medium	High	High
18	Karr and Steckelberg (2014)	High	Medium	High	High
19	Kobak and Taskin (2012)	Medium	Medium	Medium	Medium

ID	Studies	WoE A	WoE B	WoE C	WoE D
20	Koc and Bakir (2010)	Medium	Low	Medium	Medium
21	Orhan Goksun, Filiz, and Kurt (2018)	Low	Low	Medium	Low
22	Yağci (2016)	High	Medium	Medium	Medium
23	Yapici, Hevedanli, Isman, Liu, and Kiyici (2012)	Medium	Low	Low	Low
24	Yuksel, Kavanoz, Karahoca, and Kanbul (2011)	High	Medium	Low	Medium
25	Q. Zhou et al. (2010)	High	Low	Medium	Medium

Table 11. Summary of Quality Assessment of Included Studies Using Weight of Evidence Framework

	WoE A	WoE B	WoE C	WoE D
High	12	2	7	6
Medium	12	16	16	17
Low	1	7	2	2
Grand Total	25	25	25	25

Table 12. Scale Count of Weight of Evidence Judgments

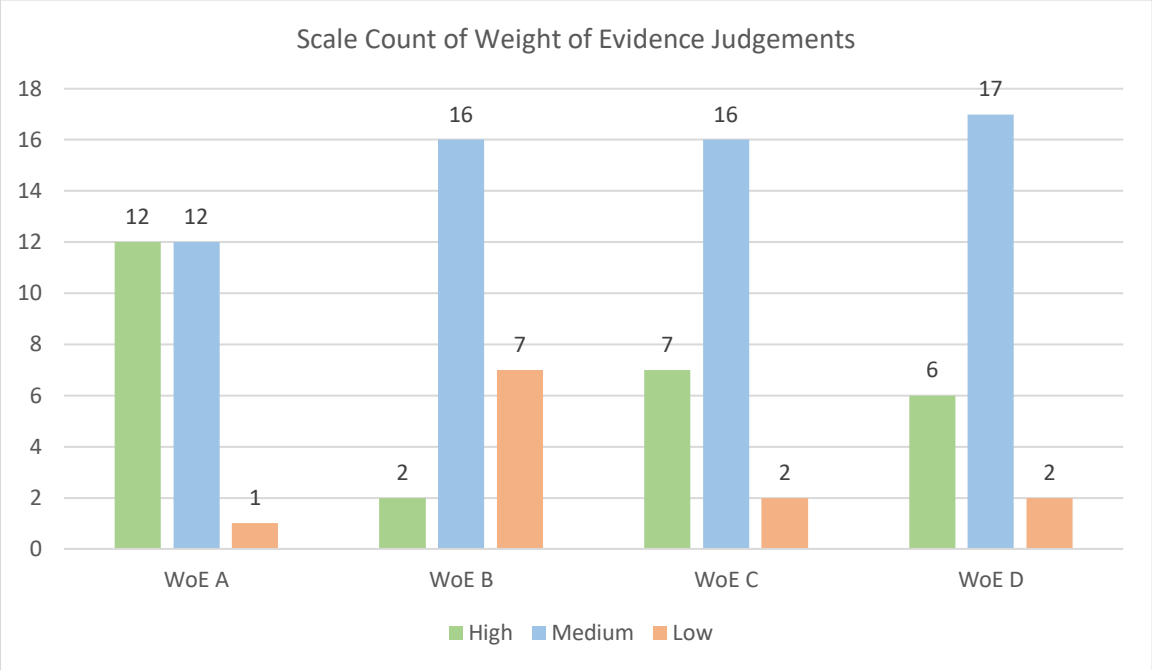

Figure 5. Bar Chart for Weight of Evidence Judgments

4.4 Findings

4.4.1 Overview

The search strategy has resulted in the inclusion of 25 studies. Table 15 demonstrates an overview of all included studies with key information on study types, research methods, settings, subjects, regions, sample size, sampling strategy, instruments, and findings. More detailed information, such as the general descriptions (study types, research methods, research aims, and research questions), methodology descriptions (settings, subjects, regions, sample size, sampling strategy, ethical considerations, instruments, and data analysis), and outcome descriptions (findings and implications) of included studies, is presented in Appendix I (see Table 28, Table 29 and Table 30).

The frequency of some descriptors in the included studies is shown in Table 13. The majority of included studies are journal articles (n=19), other types of study including thesis (n=3) and conference proceedings (n=3). Most of the studies adopted quantitative research methods (n=15), a few studies used mixed methods (n=6) and qualitative

methods (n=4). In terms of the settings of research, 13 studies have no relevant information stated in the research, and rest of the studies are about primary school (n=3), secondary school (n=3) and mixed settings (n=6). The subject area of the included studies can be categorized into science (n=10), social science (n=1), arts and humanities (n=4), and mixed subjects (n=3); still, 7 studies have not stated any relevant information on specific subjects. As for the regions of the included studies from 10 regions, most of the studies were from Turkey (n=14); other regions include the USA (n=3), Cyprus (n=2). In addition, Australia, China, Ghana, Romania, Saudi Arabia, South Africa, and Singapore have each one study included in this review respectively.

Descriptors	Frequency
Study Types	
Journal	19
Thesis	3
Proceedings	3
Research Methods	
Mixed	6
Quantitative	15
Qualitative	4
Settings	
Primary School	3
Secondary School	3
Mixed	6
Unspecified	13
Subjects	
Science	10
Social Science	1
Arts and Humanities	4
Mixed	3
Unspecified	7
Regions	
Turkey	14*
USA	3
Australia	1
China	1
Cyprus	2
Ghana	1
Romania	1
Saudi Arabia	1
South Africa	1
Singapore	1

* One study included the participants from two regions: Turkey and Singapore.

Table 13. Frequency of Descriptors in Included Studies

As for the research instruments used in the included studies, most of the research employed questionnaires either adopted or modified from previous research studies (e.g. Yavuz Akbulut, 2009; Albirini, 2006; Cavas, Cavas, Karaoglan, & Kisla, 2009; Chan & Elliott, 2004; E. Jung, Rhodes, & Vogt, 2006; Kinzie & Delcourt, 1991; Kubiatko & Haláková, 2009; Medcalf-Davenport, 1998; Teo, Chai, Hung, & Lee, 2008; Tınmaz, 2004a; Yavuz, 2005), or developed by the researchers themselves. A few studies have conducted interviews to elicit pre-service teachers' opinions on ICT in depth.

Two studies used metaphor to analyze pre-service teachers' perceptions to ICT. The result of Gok and Erdogan (2010) have showed nine categories as "needed", "constantly changing", "developing", "harmful", "beneficial",

“addictive”, “both beneficial and harmful”, “rapidly improving” and “facilitating our life”. Also, it is pointed out that pre-service teachers perceive technology mostly as “both beneficial and harmful” and “addictive” at the very least. In the study of Kobak and Taskin (2012), prospective teachers have developed metaphors into nine categories about the attitudes toward technology: developing and changing technology (with maximum number of frequency), rapidly progressing technology, limitless, endless technology, beneficial technology, harmful technology (with minimum number of frequency), both beneficial and harmful technology, unputdownable technology, technology as a necessity, and all-inclusive technology. It also presents that the prospective teachers ranked Smart boards, internet, and computers as the three technologies that can represent the concept of using technology in education the most appropriately by ranking the images according to the order of importance.

In the document review conducted by Orhan Goksun et al. (2018), they found that that pre-service teachers’ views on the most representative educational technologies in the past were CD and television; the most frequent forms on educational technologies of present were Smart boards and online courses; and the concepts of holograms, virtual classrooms, real e-books, and interactive desks were mentioned frequently as educational technologies in the future.

With regard to the result of perceptions of pre-service teachers in 25 studies, it includes positive perceptions (e.g. Alblaihed, 2016; Alkan & Erdem, 2010; Bansilal, 2015; Baz, 2016; Birkollu et al., 2017; S. Can, 2016; Eyyam et al., 2010; Incik & Akay, 2017; Karr & Steckelberg, 2014; Kobak & Taskin, 2012; Yağci, 2016; Yapici et al., 2012; Yuksel et al., 2011; Q. Zhou et al., 2010), negative perceptions (e.g. Y. Akbulut et al., 2011; Hismanoglu, 2012b), mixed perceptions (e.g., Delaney et al., 2014), and neutral perceptions (e.g. Koc & Bakir, 2010).

In the included studies, the reasons pre-service teachers have positive perceptions towards ICT include but are not limited to these aspects: 1) technology plays an important role in teaching and learning and it helps teaching and learning; 2) technology is essential for the communication between teachers and students; 3) the available technology equipment would suit learner-centered teaching strategy; 4) the availability of ICT tools encourages teachers to use technology in teaching; 5) ICT tools can be a replacement of traditional non-technological teaching tools; 6) the use of ICT tools can support the dynamic nature of teaching complex and difficult concepts; 7) technology is trending and an inevitable element in future teaching and learning; 8) the educational technology tools can potentially bring improvement to schools and classrooms.

Additionally, these are some reasons pre-service teachers hold negative perceptions towards ICT: 1) It is not easy to overcome the technical issues as obstacles; 2) integrating ICT tools in a teaching session is time consuming, especially when the teacher is busy or preoccupied with other tasks; 3) the complexity of curriculum increases the complexity of integrating ICT tools in teaching; 4) it is not always easy to be prepared to use ICT tools in the classroom because of anxiety, insufficient competency, unreadiness, or just “not in the mood”; 5) there are not sufficient resources available or there is no access to the technology tools; 6) there is a sense of “duty” to use technology, but it may be a burden in some ways; 7) there is insufficient training regarding the theoretical and practical guidance for ICT infusion.

4.4.2 Review Question 1

Review Question 1: What are the variables of ICT beliefs measured in the studies such as gender, subjects, culture, country development stage, technology adoption stage, or pedagogical context differences?

Totally 19 variables pertaining to pre-service teachers' ICT beliefs are measured in the included studies. These variables can be classified into four categories:

1) Personal Characteristics: age (Chisalita et al., 2012; E. J. Jung & Rhodes, 2004), gender (Y. Akbulut et al., 2011; Alkan & Erdem, 2010; Birkollu et al., 2017; S. Can, 2016; Incik & Akay, 2017; E. J. Jung & Rhodes, 2004; Karr & Steckelberg, 2014; Kobak & Taskin, 2012; Yağci, 2016; Yapici et al., 2012; Yuksel et al., 2011) and ethnicity (E. J. Jung & Rhodes, 2004);

2) Pedagogical Characteristics: department, subject domain, or educational program (Y. Akbulut et al., 2011; Alkan & Erdem, 2010; Birkollu et al., 2017; Incik & Akay, 2017; Karr & Steckelberg, 2014; Yuksel et al., 2011), university or school settings (Alblaihed, 2016; S. Can, 2016; Chisalita et al., 2012; Yuksel et al., 2011), grade level (Birkollu et al., 2017; S. Can, 2016; Incik & Akay, 2017; E. J. Jung & Rhodes, 2004; Yağci, 2016; Yapici et al., 2012), class types (S. Can, 2016), GPA/academic success level (E. J. Jung & Rhodes, 2004; Yağci, 2016), teaching application status (Alkan & Erdem, 2010), teacher education program admittance status (E. J. Jung & Rhodes, 2004), and teaching level such as elementary education, secondary education, special education, K-12, or other levels (E. J. Jung & Rhodes, 2004; Karr & Steckelberg, 2014).

3) Technological Characteristics: ICT use frequency (Y. Akbulut et al., 2011; Birkollu et al., 2017), ICT attributes including advantage, compatibility, complexity and observability (Q. Zhou et al., 2010) , technology ownership (Karr & Steckelberg, 2014), and technology competency (Incik & Akay, 2017; E. J. Jung & Rhodes, 2004; Karr & Steckelberg, 2014; Q. Zhou et al., 2010)

4) Other Characteristics: leadership support and job relevance (Gyamfi, 2017), thinking styles (Yağci, 2016), and perception of culture (Q. Zhou et al., 2010)

Within expectations, the most mentioned variables are gender (n=11), department, subject domain, or educational program (n=6), grade level (n=6), university or school settings(n=4), and technology competency (n=4). More details of the variables measurement in included studies are summarized in the Table 14.

Categories	Variables of ICT Beliefs	Frequency	Studies with Significant Difference	Studies with No Significant Difference
1) Personal Characteristics	Age	2		Chisalita et al. (2012); E. J. Jung and Rhodes (2004)
	Gender	11	Y. Akbulut et al. (2011): Females' evaluations were more positive in terms of Learning Communities. Other indicators did not differ between males and females. Birkollu et al. (2017): It is revealed self-efficacy perceptions of male teachers towards computer are higher compared to female teachers' self-efficacy perceptions towards computer. S. Can (2016): The attitudes of female students are more positive than the attitudes of male students. E. J. Jung and Rhodes (2004): Male students were significantly higher on technology predisposition scores and the differences were significant. Yuksel et al. (2011): Males' attitude scores are significantly higher than that of the females.	Alkan and Erdem (2010); Incik and Akay (2017); Karr and Steckelberg (2014); Kobak and Taskin (2012); Yağci (2016); Yapici et al. (2012)
	Ethnicity	1		E. J. Jung and Rhodes (2004)
2) Pedagogical Characteristics	Department, Subject Domain, or Educational Program	6	Y. Akbulut et al. (2011): Departments of computer science education and preschool education had significantly higher means. Birkollu et al. (2017): There is a significant difference between Guidance and Psychological Counseling and Computer Education and Instructional Technologies in favor of the Department of Computer Education and Instructional Technologies. Incik and Akay (2017): The score of pre-service teachers' perception about technology who have education at English Language Teaching Department is higher.	Alkan and Erdem (2010); Kobak and Taskin (2012); Yuksel et al. (2011)
	University or School Settings	4	Alblaihed (2016): The school settings seem to play a vital role in the pre-service teachers' decision to either use or not to use technology. S. Can (2016): There is a significant correlation between the students' attitudes and the type of the high schools they graduated from, and the region where the university attended is located.	Chisalita et al. (2012); Yuksel et al. (2011)
	Grade Level	6	Birkollu et al. (2017): A significant difference was observed between second-year students and fourth-year students in favor of fourth-year students in terms of their attitudes towards technology. E. J. Jung and Rhodes (2004): The predisposition scores of senior students were significantly higher than the other groups	S. Can (2016); Incik and Akay (2017); Yağci (2016); Yapici et al. (2012)
	Class Types	1	S. Can (2016): Day-time students' attitudes toward education technologies are more positive when compared to the attitudes of the evening students	
	GPA/Academic Success Level	2	Yağci (2016): This result indicates that there is positive and proportional relationship between pre-service teachers' academic success levels and their attitude towards the effect of the ICT on education and teaching.	E. J. Jung and Rhodes (2004)
	Teaching Application Status	1	Alkan and Erdem (2010): The attitudes of student teachers who received teaching application towards educational technologies were more positive than the student teachers who had not received teaching application.	
	Teacher Education Program	1		E. J. Jung and Rhodes (2004)

	Admittance Status			
	Teaching Level	2		E. J. Jung and Rhodes (2004); Karr and Steckelberg (2014)
3) Technological Characteristics	ICT Use Frequency	2	Y. Akbulut et al. (2011): Those who used ICTs more often seemed to have higher means than those who used them less frequently. Birkollu et al. (2017): There are significant differences based on pre-service teachers' attitudes towards technology and average hours of computer use per day in favor of pre-service teachers who use less than one hour and 5 hours and above.	
	ICT Attributes	1	Q. Zhou et al. (2010): An examination of individual computer attributes shows that respondents were most positive about the observability of computers.	
	Technology Ownership	1	Karr and Steckelberg (2014): This study found a positive correlation between the amount of technology a candidate owned and their technology disposition.	
	Technology Competency	4	Incik and Akay (2017): There is positively significant relationship between pre-service teachers' techno-pedagogical educational competency and perception towards technology. Q. Zhou et al. (2010): Computer competence was significantly related to teachers' attitudes.	Y. Akbulut et al. (2011); Q. Zhou et al. (2010)
4) Other Characteristics	Leadership Support and Job Relevance	1	Gyamfi (2017): Leadership support significantly influenced perceived ease of use and job relevance significantly influenced perceived usefulness.	
	Thinking Styles	1	Yağci (2016): There is a positive and moderate level of significant relationship between "innovative thinking style" and attitudes of preservice teachers.	
	Culture Perception	1	Q. Zhou et al. (2010): Cultural perceptions yielded significant relationships with pre-service teachers' attitudes	
	Income	1		Y. Akbulut et al. (2011)

Table 14. Categories and Variables Details of ICT Beliefs in Included Studies

4.4.3 Review Question 2

Review Question 2: What are the reported factors that affect their adoption of various ICT tools in the teaching and how?

Less than half of the included studies mentioned the factors that affect pre-service teachers' adoption of various ICT tools in their teaching. According to Alblaihed (2016), the factors that influenced and shaped their use of technology in the classroom include social factors (e.g., relationships with others), technical factors (e.g., technical support and training), pedagogical factors (e.g., motivations to use specific strategies) in addition to other factors such as the availability of technological equipment, students' interest in technology, the use of technology by university staff, the strategy of preparing pre-service teachers for technology use, organizational challenges, and the like. It is noted that teachers in schools and the expectations of the school for the use of technology play an important role in the decisions about adopting technology when advice and support are provided for pre-service teachers, but it is concerning that there are still gaps between the university programs and the schools' reality and needs, as well as the gaps between theory and practice when using technology in teaching. One of the obstacles using technology in the school setting is reported in this study, i.e., the lease of school buildings or school premises. As some of the schools lease buildings during the academic terms that are not designed for teaching and learning, the conditions of ICT facilities are compromised either due to the lack of equipment, or confined classroom space that is too small to include technological equipment. Another obstacle that is widely reported from the participants in the research is the lack of technical training and support.

Bansilal (2015) has addressed the conventions and artifacts in the teaching of mathematics, where the use of technology was limited. Also, many of the pre-service teachers in the study reported that they had limited access to technology during their teaching practice in under-resourced rural schools. It also stated that effective use of technology can improve the learning experiences; technology can ease the tasks of teaching and learning; and effective use of technology helps learners see connections between representations. In this research, these factors are reported that can promote pre-service teachers to adopt various ICT tools in the classroom: 1) Activity Structures: the use of technology can help to find explanations and solutions to related problems, also the technology made it possible to bring two different representations (graphical and symbolic) together. 2) Social Interactions: accessible social media platforms have changed the ways in which they interact with their peers such as asking peers for help and sharing solutions of problems.3) Prior Understandings: learners' insufficient exposure to technology as an issue that both facilitated and limited the learners' engagement with technology-based lessons would constrain the ICT adoption scope as pre-service teachers since technology could be a useful tool to provide a variety of strategies, examples, and representations to deal with mathematics concepts. 4) Emergent Goals: technology is perceived as a tool to help with the teaching preparation and as a vehicle to help learners understand mathematical situations; nevertheless, it also demotivates pre-service teachers' willing to work out problems on their own.

Baz (2016) concluded that the use of technology can increase learner engagement and teaching practicality because the student teachers think technology attracts the attention of the learners. Although having the advantage of convenience, as a time-saving tool, the use of ICT tools may make learners and student teachers less creative and reliant to some extent or can be even abused by the learners. Similarly, Eyyam et al. (2010) has revealed that the positive attitude of pre-service teachers towards the use of instructional technology can benefit students more from the lessons and make learning more interesting and attractive for their prospective students.

Q. Zhou et al. (2010) suggests that as technology is pertinent to schools and society, it represents viable means for the improvement of education and the standard of livelihood; thus, it is necessary to know the needs and reality of ICT adoption for future jobs, and to address the needs of social issues before implementing technology in education. Other affective factors with respect to ICT adoptions are covered by pedagogical beliefs (Gurcay et al., 2013), technology experience (Y. Akbulut et al., 2011), enjoyment, enthusiasm, and self-confidence to ICT (Dogan et al., 2011), and innovative thinking style (Yağci, 2016). Additionally, Gyamfi (2017) has directly pointed out that relevant ICT training can enhance pre-service teachers' ICT competency which could help them develop positive attitudes towards ICT; as a result, their intention of ICT adoption for pedagogical purpose will increase in their future teaching.

4.4.4 Review Question 3

Review Question 3: What are the recommendations regarding the ICT training needs of pre-service teachers when investigating their ICT beliefs and perceptions?

As Karr and Steckelberg (2014) have pointed out, it is necessary to measure pre-service teachers' current attitudes and beliefs toward technology integration first, which will not only impact the effectiveness of the training but also the students' attitudes toward using technology for learning. The training needs can be determined later according to the pre-service teachers' beliefs on ICT, the willingness to integrate technology in the classroom, and the assumption of the adequacy in ICT expertise (Koc & Bakir, 2010). Also, the bridge of technology usage between social interaction and training preparation can help the understanding of the current situation of their technology competence and the potential provision of necessary training. The information on the plan of pre-service teachers' professional development, and the school requirement of technology integration are also valuable on assisting the training bodies to identify the types of competencies that candidates need to develop in the areas of effective teaching and technology integration. Additionally, teacher education programs, school districts, and accrediting bodies should be involved collaboratively to provide pre-service teachers confidence and technology troubleshooting ability by maximizing the effectiveness both during and after the training.

The purposes of training mentioned in the included studies contain improving technical understanding, keeping up with technological developments, reducing ICT anxiety, increasing ICT confidence, and gaining ICT competency (Bansilal, 2015; Baz, 2016; Dogan et al., 2011; Hismanoglu, 2012b; Karr & Steckelberg, 2014). To achieve these goals, the ICT training content should be considered thoroughly. Some studies have suggested that the training specific to the use and the troubleshooting of a variety of technologies (Karr & Steckelberg, 2014), the implementation strategies of the most frequent use of technology into teaching in their course work or early field experience (Koc &

Bakir, 2010), the pedagogical rationale and cognitive contributions of technology underlying technology integration (Koc & Bakir, 2010), the integration of methodologies and practices of ICT (Hismanoglu, 2012b), the integration of pedagogical knowledge and ICT applications into their teaching (Baz, 2016; Gurcay et al., 2013), along with meaningful and instructional ICT use experiences (Y. Akbulut et al., 2011; Dogan et al., 2011; Yapici et al., 2012) could generate and yield a more fruitful and high-level technology-supported instruction.

Studies have suggested that pre-service teachers may need additional support and training, such as in the areas of more advanced and emerging tools including computer maintenance, web design, video editing software, performance assessment software, WebQuests, concept mapping tools and simulations, databases (Karr & Steckelberg, 2014; Koc & Bakir, 2010), and even in the area of how to access technological tools technically (Baz, 2016). Also, the strategies of adopting engaging activities, authentic materials, effective technology integration, learner-centered, collaboration, authentic and inquiry-based learning environments, addressing questions, problems, and issues related to technology integration, accomplishing technology integrated instructional projects, evaluating existing cases of ICT integration in teaching, encouraging sharing with their peers, and problem-based learning supported by ICT can be included in the training classes. These strategies can be regarded as good role models for ICT-integrated teaching, by contributing to the formation of positive attitudes, assisting the understanding of the strategies to use technologies as tools to enhance teaching and learning, and generating effective and direct experience of the training to pre-service teachers (Dogan et al., 2011; Gurcay et al., 2013; Incik & Akay, 2017; Koc & Bakir, 2010).

Alblaihed (2016) has recommended that the partnership between universities and schools needs to attract more attention to improve the quality of pre-service teachers' ICT training by linking the ICT adoption with the reality and the needs of schools, since there is a disconnection between university teacher training programs and the real needs of schools to some degree. In terms of the training methods, face-to-face instruction by involving ICT-integrated sample lessons (Hismanoglu, 2012b) and training seminars about integrating current technology through learning environments can be conducted by educational technology specialists (Incik & Akay, 2017). Distance teacher training programs and accessible web-based training should be reconsidered, since more conducive and non-threatening learning environments can be provided compared to face-to-face programs, and pre-service teachers can select the learning sources based on their own interests, pace, and time. (Hismanoglu, 2012b; Koc & Bakir, 2010). In addition, Karr and Steckelberg (2014) have suggested that by offering stand-alone technology courses and integrating technology training throughout the preparation program, it can assist teacher preparation institutions constantly to develop the programs that meet the changing needs of technology use in the classroom, while Koc and Bakir (2010) have argued that teacher training programs should emulate the effective use of technology by incorporating it throughout the entire curriculum that emphasizes the applications in real situations, rather than exclusively offering stand-alone technology courses. It is also important to note that offering ICT training, guidance, and support for new teachers is necessary at the beginning of their teaching careers, as the technology is continuously changing (Karr & Steckelberg, 2014).

ID	Studies	Study Types	Research Methods	Settings	Subjects	Regions	Sample Size (n=)	Sampling Strategy	Instruments	Findings
1	Y. Akbulut et al. (2011)	Journal	Quantitative	Unspecified	Unspecified	Turkey	2515, 2627	combination of stratified random sampling and systematic sampling	A personal information form and 75 items survey from Akbulut (2009), α =.96	Perceptions differed with regard to different departments, gender and frequency of ICT use for instructional purposes whereas they did not vary with regard to income, PC experience, and having a PC at home. Teacher training programs did not facilitate the effective integration and use of ICTs for instructional purposes sufficiently.
2	Alblaihed (2016)	Thesis	Mixed	primary school	science and mathematics	Saudi Arabia	Survey: 53 Interview: 7	non-probability sampling strategy	Modified TPACK questionnaire (Koehler, 2011), semi-structured classroom observations, and semi-structured interviews. Pre-service teachers who use technology, pre-service teachers who do not use technology to collect both quantitative and qualitative data	All the pre-service teachers believed that technologies are regarded as an essential and important part of teaching and learning process nowadays. All of the five participants who used technology mentioned that the use of technology in the classroom could improve the pupils' learning and help in achieving the lessons' aims in a better way. Visualizing concepts through technology is the appropriate representation for the school level of primary school and the age range of the pupils. It can be argued that they used it because the required technology that suited their teaching strategy was available at school. In some cases, the participants already had a strong belief in the importance of technology and had previously planned to integrate it into their school placement teaching. There were several challenges reported by the pre-service teachers, including technical challenges, time challenges and personal challenges. School, university, and the partnership between them are important factors influencing their perceptions and practices related to the integration of technology in the classroom.
3	Alkan and Erdem (2010)	Journal	Quantitative	Unspecified	Biology, Physics, Chemistry and Mathematics	Turkey	244	Unspecified	"Attitude Scale towards Educational Technology" developed by Pala (2006). Cronbach Alpha reliability coefficient was 0.92.	The present study established that student teachers have a positive attitude towards educational technologies. It was observed that the attitude towards educational technologies does not differ according to the department and gender. The attitudes of student teachers who received teaching application towards educational technologies were more positive than the student teachers who had not received teaching application.

ID	Studies	Study Types	Research Methods	Settings	Subjects	Regions	Sample Size (n=)	Sampling Strategy	Instruments	Findings
4	Bansilal (2015)	Journal	Qualitative	Unspecified	Mathematics	South Africa	52	Unspecified	written responses to a questionnaire and semi-structured interview	Access to technology has made their tasks of learning and teaching much easier; they have a greater variety of strategies available; the technology allows them to vary the pace at which they can study; it has given them access to many different resources; it has granted them more independence in learning; and it has changed the nature of communication in which they engage, amongst other things. Some benefits of mathematics software were found to be the provision of different representations, dynamic visualization of concepts and variation in mathematical situations. It was also found that students used technology more often in their own learning than in their teaching, because the schools did not have many resources.
5	Baz (2016)	Journal	Mixed	Unspecified	English	Turkey	98	Convenience sampling	the scale of attitude towards technology by Yavuz (2005). The Cronbach's alpha of the instrument is 0.8668. Focus group interview: 'What are your opinions and attitudes towards the use of technology in English language learning and teaching?'	It can be deduced from the findings that Turkish EFL student teachers in this study have positive attitudes towards the use of technology in language learning and teaching process. The student teachers in this study believe in the importance of technology in language learning and teaching and find it beneficial and seem to see technology inevitable for 21st-century learning and teaching contexts. Besides, it supports the notion that feeling ready and competent in technology promotes the development of positive attitudes. Also, it can be said that they seem to use technology for their future career and feel anxious what to do if they do not have access to the technology in their future assigned schools. However, they also feel anxious about failing to keep up with the technological innovations because of the rapid development and high learner expectations. due to the fact that they have both positive attitudes towards the technology
6	Birkollu et al. (2017)	Journal	Quantitative	Unspecified	Psychology, Education, Computer Science	Cyprus	132	simple random sampling	Demographic information and Technology towards	Results of the present study showed that attitudes of pre-service teachers towards technology are positive and significant differences were obtained between various variables and attitudes towards technology among pre-service teachers. It was revealed that attitudes towards

ID	Studies	Study Types	Research Methods	Settings	Subjects	Regions	Sample Size (n=)	Sampling Strategy	Instruments	Findings
									Attitude Scale (Yavuz, 2005)	technology significantly differ based on gender, attending a course before, department variable and their class level variable.
7	S. Can (2016)	Journal	Quantitative	Unspecified	physical education and sports	Turkey	5120	Unspecified	Demographic features of the students and a 43-item Questionnaire of Attitudes towards Education Technologies developed by Pala (2006). Cronbach's Alpha coefficient 0.877	The present study revealed that the general attitude of the students is in the category of "Agree" and hence, they have positive attitude. There is a significant relationship between the students' attitudes towards education technologies and whether they attended daytime or evening classes. The attitudes of daytime students are more positive than the attitudes of evening students. The study also revealed that the attitudes of the students of physical education and sports vary significantly depending on gender. This difference favors the female students as they exhibited more positive attitudes than the male students. There is a significant difference based on the type of the high schools they graduated from, and between the students' attitudes towards education technologies. There is a significant difference based on the region where the university attended is located, and the students' attitudes towards education technologies. No significant difference based on grade level was found among the students' attitudes towards education technologies, and the distribution of students among the grade levels are nearly even.
8	Chisalita et al. (2012)	Proceedings	Quantitative	Preschool and Primary School	Unspecified	Romania	120	Unspecified	The ICT attitude of student teachers	The identified significant differences regarding the wireless internet and international databases access at the two faculties may suggest that students do not know about the existence of these two facilities in the faculty (still not) or do not know how to use them properly. Difficulties of the access to ICT resources encountered by students can be grouped into four main categories: problems related to hardware access (insufficient computers, old computers), difficulties related to ICT skills (lack of ICT skills), problems related to software equipment (different programs, internet connection) and problems related to time resources (not enough time to practice). Greater exposure to ICT resources of students

ID	Studies	Study Types	Research Methods	Settings	Subjects	Regions	Sample Size (n=)	Sampling Strategy	Instruments	Findings
										from this generation may be the explanation of the difference observed between students of different age groups categories in terms of difficulties.
9	Delaney et al. (2014)	Proceedings	Qualitative	primary and secondary school	Science	Australia	220	Unspecified	survey	Most respondents were able to provide a favorable vision for using technology, albeit on a personal level. The majority of respondents were unable to either describe an approach to incorporate technology in the classroom beyond rote/repetition uses, or describe an educational affordance of technology in their goals and visions statements.
10	Dogan et al. (2011)	Proceedings	Quantitative	primary	mathematics	Turkey	125	Unspecified	self-developed questionnaire as a survey (α = 0.84)	studying and teaching mathematics both for students and teachers. They appreciate possible enhancements to individual mathematics learning with the opportunities provided by the technology. Trainee teachers accept that materials and technology help to teach and learn mathematics better. Enjoyment, enthusiasm and self-confidence are very important affective factors in learning and teaching mathematics. Trainee teachers largely disagree with statements about the uselessness of materials and technology in mathematics.
11	Eyyam et al. (2010)	Journal	Quantitative	Unspecified	English	Cyprus	47	Unspecified	The scale was designed and prepared by the researchers.	The results revealed that prospective English teachers at EMU have positive attitudes towards the use of instructional technology and they believe in the benefits of instructional technology. The results also revealed that the teachers' positive attitude towards the use of instructional technology will mostly help students to benefit more from the information they will be provided. Moreover, the results showed that this positive attitude will help teachers use more instructional technology tools and make learning more interesting and attractive for their prospective students.
12	Gok and Erdogan (2010)	Journal	Qualitative	Primary	Unspecified	Turkey	487	convenience sampling	Metaphors were used in collecting qualitative data in this study. First part of the form includes personal	In the study, the pre-service teachers' perceptions related to technology is consisted of nine categories as "needed", "constantly changing", "developing", "harmful", "beneficial", "addictive", "both

ID	Studies	Study Types	Research Methods	Settings	Subjects	Regions	Sample Size (n=)	Sampling Strategy	Instruments	Findings
									information related to various variables and the second part includes the completion of the sentence "Technology is like .. because .."	beneficial and harmful", "rapidly improving" and "facilitating our life". Pre-service teachers perceive technology mostly as "both beneficial and harmful" and "addictive" at the very least.
13	Gurcay et al. (2013)	Journal	Quantitative	secondary	physics	Turkey, Singapore	205	convenience sampling	The study employed two sets of survey instruments: the Teaching and Learning Conceptions Questionnaire (Chan and Elliott 2004) and the Use of Technology Questionnaire (Teo et al. 2008).	The results of this research indicate that both Turkish and Singaporean pre-service physics teachers are more inclined towards CT rather than TT. No statistical differences were detected between the Singaporean and Turkish pre-service physics teachers' pedagogical beliefs. However, a statistically significant difference was detected between Turkish and Singaporean pre-service physics teachers' Constructivist use of technology beliefs. ICT beliefs are positively correlated with constructivist use of technology, as expected. However, ICT beliefs are also positively correlatedwith traditional use of technology.
14	Gyamfi (2017)	Journal	Quantitative	Unspecified	Unspecified	Ghana	380	random sampling	Apart from the demographic profile, the respondents responded to 17 statements on job relevance (JR) (3 items), leadership support (LS) (2 items), perceived usefulness (PU) (4 items), perceived ease of use (PEU) (4 items) and attitude towards	(1) leadership support significantly influenced perceived ease of use; (2) job relevance significantly influenced perceived usefulness; (3) perceived usefulness significantly influenced attitude towards use; (4) perceived ease of use significantly influenced attitude towards use (5) the TAM is significant for pre-service teacher education context except the relationship between perceived ease of use and perceived usefulness.

ID	Studies	Study Types	Research Methods	Settings	Subjects	Regions	Sample Size (n=)	Sampling Strategy	Instruments	Findings
									use (ATU) (4 items).	
15	Hismanoglu (2012b)	Journal	Mixed	primary and secondary	English	Turkey	85	Unspecified	A questionnaire was developed by the researchers to gather data about the perceptions of prospective EFL teachers in distance higher education towards ICT integration.	This research study done in a distance higher education context unearthed negative teacher attitudes towards the use of ICT in language teaching. Lack of exposure to lessons fully designed with ICT tools, lack of opportunities to try ICT, the need to practice in a technology laboratory, lack of educational technology teachers, an exam-driven education system and studying to learn only what is to be tested were some of the underlying reasons for the prospective EFL teachers' negative perceptions of ICT use in the language learning or teaching process. The results of this study also apparently show that despite having basic computer skills, prospective EFL teachers in distance education were not confident in using the technology to improve their own productivity and bring about a pedagogical change in their teaching methods. Moreover, this research study reveals that prospective EFL teachers in distance higher education, despite having negative attitudes toward ICT integration and not utilizing it in the classroom, viewed ICT as a tool to help them to learn many things. Finally, it is obvious that unless teachers perceive the new technologies as valuable, they will be unwilling or unable to use them meaningfully.
16	Incik and Akay (2017)	Journal	Mixed	Mixed	Mixed	Turkey	626, 67	Unspecified	Techno-pedagogical Education Competency (TPACK-Deep) Scale, Kabakci Yurdakul et al. (2012). Technology Perception Scale, developed by Tinmaz (2004).	It was concluded that pre-service teachers generally regard themselves at moderate levels in the sense of technopedogogical education competency. Findings of the study show that pre-service teachers have positive perception towards technology. The findings of the current study show that pre-service teachers' competency level about technopedogogical education and their technological perception do not differ according to gender and department. The findings of this study show that pre-service teachers' technopedogogical educational competency and perception towards technology differ significantly on behalf of pre-service teachers who study at English Language Teaching

ID	Studies	Study Types	Research Methods	Settings	Subjects	Regions	Sample Size (n=)	Sampling Strategy	Instruments	Findings
										Department. The findings of the current study show that there is a positively significant relationship between pre-service teachers' technopedogogical educational competency and perception towards technology. According to the results of qualitative analysis of the study, pre-service teachers think that educational technologies have contributions to preparing ICT-based presentations, developing technology-based materials, preparing homework, doing research, raising awareness about importance of educational technology use in the learning and teaching process, acquiring information about their department, developing personal skill of using technology based on information-communication technologies and having a positive attitude toward technology in general.
17	E. J. Jung and Rhodes (2004)	Thesis	Quantitative	Mixed	Unspecified	USA	656	purposive sample	Preservice Teacher Technology Survey (PTTS), a combination of the selected or modified items from two different instruments adapted from Technology Survey for All Education Students (Medcalf Davenport, 1998) and Attitude toward Computer Technologies (Deicourt & Kinzie, 1993), and	Male students were significantly higher on the overall technology disposition scores than female students, but the differences were due to their strong self-concept, especially self-confidence, which was the subset of self-concepts. Students' technology competence level was significantly higher for seniors than for sophomores. The overall technology disposition scores significantly changed between their junior and senior years. No significant differences were found according to age, ethnicity, teaching level, teacher education program admittance status, and college GPA. The TDS-T demonstrated content validity through factor analysis, and convergent and discriminant validity through item analysis. Value for Cronbach' alpha was .93, indicating highly satisfactory reliability.

ID	Studies	Study Types	Research Methods	Settings	Subjects	Regions	Sample Size (n=)	Sampling Strategy	Instruments	Findings
									researcher-developed items.	
18	Karr and Steckelberg (2014)	Thesis	Quantitative	Secondary	Unspecified	USA	476	convenience sampling	Technology Disposition Scale for Teacher Education Students (TDS-T) (Jung, Rhodes, & Vogt, 2006).	This study found the students attitudes and beliefs were positive toward technology integration. They were strongest in areas dealing with long-term beliefs: technology as in inevitable tool in the classroom, agreeing they will incorporate technology in the classroom, and using it to assist in organizing their work. The questions where they scored lowest dealt with self-confidence or self-concept. It was also found that personal ownership of a number of different technologies correlated with technology disposition. It would seem that the more technology owned would lead to more confidence and likelihood an individual would use technology not only for personal use but also within their work. Student teachers that perceive themselves as competent in using technology had higher overall technology dispositions. Sense of competency comes from experiences and usage. Owning the technologies would give an opportunity for increase use, and ultimately skill. Students that own and use technology may have better attitudes toward its use in their classroom. Training to provide knowledge in how to use a variety of technologies, troubleshoot those technologies, and integrate them in the classroom is essential to their success with technology. Another area of interest, from the data, comes from student's self-reported competencies.
19	Kobak and Taskin (2012)	Journal	Mixed	Secondary	science and mathematics	Turkey	104	Unspecified	Technology Perception Scale, by Tinmaz (2004) Visual Association Activity: there are 11 images to be listed in order of importance. Metaphors: "Technology is	It can be said that prospective teachers have positive perceptions concerning technology. There is no difference between prospective teachers in terms of gender in this study. no significant difference between prospective teachers in terms of undergraduate program. The results of visual association activity showed that the most show that prospective teachers ranked smart board, computer and internet in the first place and camera/ video, mobile phone which they commonly associate them with the

ID	Studies	Study Types	Research Methods	Settings	Subjects	Regions	Sample Size (n=)	Sampling Strategy	Instruments	Findings
									like ...., because ...."	Technology using concept in education and portable media players (mp3/mp4) in the last place.
20	Koc and Bakir (2010)	Journal	Mixed	Mixed	Mixed	USA	26	Unspecified	1) demographic information and background information on their technology experience; 2) perceptions and beliefs about participants' knowledge and preparation to various aspects of using available technology; 3) participants' current level of knowledge and skills for using a variety of technological applications.	In this study, participants were neutral about their readiness to use technology in their teaching. Nevertheless, majority of the participants indicated that they need more training to learn how to implement computer technologies in order to enhance their students' learning. They also indicated that technology was frustrating to use when adequate support was not received. Another indicator of such a need for more training was the lack of knowledge that was the most frequently explained impeding factor in pre-service teachers' implementation of computer technology into teaching in their course work or early field experience. Moreover, pre-service teachers should be taught about the nature of technology and its alternative roles in educational contexts other than searching and presenting information and time-saving applications. The study indicated that pre-service teachers still use technologies within the objectivist model of teaching and learning.
21	Orhan Goksun et al. (2018)	Journal	Qualitative	Unspecified	Unspecified	Turkey	65	convenience sampling	document review	Participants considered "CD" (f=32) and "Television" (f=32) as educational technologies of past most frequently. Suggesting the most frequent views of educational technologies of present are "Online courses" (f=23) supported this idea. The most remarkable findings of study may be foresights of student teachers' educational technologies of future. Student teachers dwelled on some technologies such as "Hologram" (f=26), "Virtual classroom" (f=22), "Real e-books" (f=18) and "Fiber plastic desks" (f=15). The most frequent views were created under educational technologies of past (f=241) and educational technologies of present (f=240) themes.

ID	Studies	Study Types	Research Methods	Settings	Subjects	Regions	Sample Size (n=)	Sampling Strategy	Instruments	Findings
22	Yağci (2016)	Journal	Quantitative	Unspecified	Sciences	Turkey	186	Unspecified	Thinking Styles Scale, Turkish by Subu (2004) Attitude Scale toward the ICT, Cavas et al. (2009)	Preservice teachers from the CEIT department at most preferred innovative thinking style which likes to deal with indetermined indefinite works and which exhibits innovative and visionary characteristics. Thinking styles preferred by participants do not exhibit significant difference gender variable. Grade level variable, similarly, is not significantly different with respect to thinking styles preferred by participants. However, it was observed that average scores have changed at grade level even though it is at minor level. Attitude of preservice teachers from the CEIT department toward the ICT does not display significant difference according to their gender. Similarly, attitude of participants toward the ICT does not display significant difference according to their grade levels. However, grade level of participants is moderately effective on their attitude toward to usage of ICT in education. There is positive and proportional relationship between academic success levels of preservice teachers from the CEIT department and their attitude toward the effect of ICT on education and teaching. It was revealed that as innovative thinking style perception level increases; their attitude toward the ICT develops in the same way. On the contrary, while perception level regarding traditionalist thinking style increases, their attitude toward the ICT decreases.
23	Yapici et al. (2012)	Journal	Quantitative	Unspecified	Biology	Turkey	70	Unspecified	Information and Communication Technology Attitudes Questionnaire-IAQ (Kubiatko ve Halaova, 2009)	The results indicate that; pre-service biology teachers have positive attitudes towards ICT using in biology teaching and although their attitudes do not differ regarding gender and class.
24	Yuksel et al. (2011)	Journal	Quantitative	Unspecified	English	Turkey	200	Unspecified	The instrument included sections on participants' demographic	Overall, the participants showed positive attitudes towards technology, as shown by the mean scores for the two subscales being 3.5 and above (on a 5-point scale). The overall positive level of attitude could be attributed

ID	Studies	Study Types	Research Methods	Settings	Subjects	Regions	Sample Size (n=)	Sampling Strategy	Instruments	Findings
									background, gender, subject domain and university type, and the Attitudes to Technology (AT) questionnaire.	to the availability and accessibility to technological tools such as computers given to the pre-service teachers at various stages of their education. With respect to independent variables, we found significant differences in attitudes by gender.
25	Q. Zhou et al. (2010)	Journal	Quantitative	Unspecified	Chemistry	China	77	Combining with the methods of stratified sampling and random sampling	A matured scale (Albirini, 2006) including attitudes toward ICT, ICT competence scale, perceptions about the relative advantage of ICT, Cultural Perceptions scale	The findings of the study indicated a very strong positive correlation between teachers' attitudes toward ICT in education and their perceptions of computer attributes. However, teachers' perceptions of the complexity of ICT with their current teaching practices were not as positive. ICT competence was the second most important predictor of computer attitudes in this study. The majority of respondents reported having little or no competence in handling most of the computer functions needed by educators. In addition, the relationship between computer attitudes and competence suggests that higher computer competence may foster the already positive attitudes of teachers and eventually result in their use of computers within the classroom. The majority of respondents regarded computers as pertinent to both Chinese schools and society and viable means for improving education and standards of living in general. What should not go unnoticed, however, is that the majority of the respondents felt that it is necessary to know how to use computer for their future jobs. In addition, many of the respondents saw that there are more important social issues to be addressed before implementing computers in education.

Table 15. Overview of Included Studies

4.5 Discussion

4.5.1 Review Outcome

This systematic review sought to examine the ICT beliefs of pre-service teachers containing the variables of ICT beliefs measurement, ICT adaptation factors and ICT training needs. The 25 included studies have provided an enhanced understanding of pre-service teachers' ICT beliefs and yield a comprehensive analysis based on the three review questions. Altogether, 19 variables were extracted relating to pre-service teachers' ICT beliefs from the included studies. Although gender, the subject domain, grade level, university settings, and technology competency are the main variables measured in the included studies, it is still impossible to draw the conclusion whether these variables have significant impact on pre-service teachers' ICT beliefs since different studies have shown different results based on the different measurement methods. Thus, meta-analysis may need to be conducted to determine the significance of these variables on pre-service teachers' ICT beliefs in the future research.

The findings of the second review question have supported the research by Ertmer (1999), it can be inferred that the main factors that affect pre-service teachers' adoption of ICT tools can be categorized to intrinsic and extrinsic factors, and the extrinsic factors potentially have a major influence on their ICT adoption. Intrinsic factors include the perception of ICT adoption, technology confidence and competence, motivation, teaching goals, etc., while extrinsic factors contain the partnership with other institutions, the availability and accessibility of technology equipment, the availability of technical support, the quality and quantity of teaching resources, the perception of learners using ICT, and the availability of high-quality ICT training courses or programs.

Drawing upon the recommendations concerning the ICT training needs of pre-service teachers when investigating their ICT beliefs and perceptions, it is worthwhile paying special attention to the identification of training needs, the purpose of training, the training content, the training delivery methods, the partnership in training courses or programs, and the availability of follow-up in-service training. Stand-alone technology and technology integration courses can be both provided by educational technology specialists to offer pre-service teachers more choices and varieties of ICT training contents and opportunities.

4.5.2 Challenges and Limitations

Although the research on pre-service ICT beliefs is firmly established in current educational field, only 25 studies are identified that met the study selection criteria. Despite the advancement of the field emerging in recent years, as is shown in the quality assessment of included studies using Weight of Evidence Framework, the progression and expansion of high quality both research and practice pertaining to pre-service teachers' ICT beliefs and ICT practice is comparatively underdeveloped, especially the research relating to pre-service teachers' beliefs and practice on the cutting-edge and the advanced technologies, such as virtual reality, augmented reality, and the like. In addition, some of the studies under review lacked sufficient background information or a theoretical framework for the research since these can provide a fundamental and starting point for readers to appraise the quality of the study and evaluate the corresponding methodology employed in the research. Due to various techniques of data collection

along with extensive data collection tools, it was challenging to examine the overall pre-service teachers' ICT beliefs underlying the different characteristics and mechanisms in each study.

Furthermore, because of the significant omissions in the reporting of methodology details, such as settings, subjects, sampling strategies, etc., along with inconclusive evidence presented, like the gaps noted in various research and notable flaws in the studies, it becomes more challenging to draw a fair and impartial conclusion based on selected studies. The missing information may hinder the interpretation of the review when associating different variables, and the landscape of the holistic presentation of the included studies. Aligned with the transparency principle in research dissemination, it is imperative that the research report is comprehensive and informative to provide a better understanding and minimize the barriers between the researchers and readers. Still, more evidence should be provided to make a more valid and reliable conclusion on pre-service teachers' ICT beliefs. Consequently, further research and critical appraisal of pre-service ICT beliefs should be conducted and monitored in the later stage. Until more robust research and conclusive evidence are established, it is recommended that teacher training should be constantly reviewing their practice in a feasible and practical manner based on the needs of their students to ensure pre-service teachers are aware of the existence and significance of ICT in their teaching.

The strength of this systematic review relies on the adoption of the systematic review methodology and the transparency of conducting the systematic review. I believe this is the first systematic review of pre-service teachers' ICT beliefs. However, the limitations of the review must also be acknowledged. As this systematic review is based on the previous work of scoping review, any issues with the scoping review will affect the result of the inclusion of the studies and the findings in the systematic review. Another limitation of this review is that the search for the literature is limited to the publications reported in English, which could lead to the reduction of precision of the findings, especially those relating to China. Although the deviation from the protocol in systematic review is pointed out in the section, owing to limited time for the review, there is still a room to advance the strategies of the review process by engaging more technical tools in the review process, and expand the volumes of included studies in this systematic review by conducting a Chinese literature search to provide a more robust synthesis of pre-service teachers' ICT beliefs. In the screening process, the researcher was the only reviewer due to the gap of the time span during and between the undertaking of the research process and the writing process, as well as the limited time to proceed the intra-reviewer and inter-reviewer reliability after the review process. Further update of the literature and the inclusion of new emerging evidence in this systematic review is needed.

4.5.3 Further Steps

This systematic review demonstrates rigorous procedural and methodological in its application, and highlights the general ICT beliefs of pre-service teachers, the measurement of ICT beliefs variables, the factors that affect the ICT adoption, and the recommendations of training needs. Meta-analysis may need to be conducted to determine the significance of the most measured variables on pre-service teachers' ICT beliefs in future research. Nevertheless, there was no research in the included studies relating to pre-service teachers' beliefs and practice on the cutting-edge and advanced technologies, such as virtual reality and augmented reality. Besides, the conduction of the

scoping review and systematic review reveals the relevant literatures in current field which provide insights into the possible ways to measure pre-service teachers' ICT beliefs. Thus, in the next chapter, an empirical research study relating to pre-service teachers' beliefs in virtual reality will be introduced by examining the status quo of pre-service teachers' ICT usage, factors of adopting virtual reality technology in teaching, and the training needs of virtual reality technology.

5. Empirical Research: Pre-service English Teachers' Perception and Training Needs of Virtual Reality in China

5.1 Rationale

Teacher education in China has developed rapidly, and relatively successfully in the last 20 years (Tang, Xun, Mu, Meng, 2001). The Resolution to Deepen the Reform of Enhancing the Teaching Staff Made by the Central Committee of the Communist Party of China and the State Council (2018) called for highly qualified, specialized, and innovative teaching staff. The resolution required teacher education to be promoted vigorously and the professional qualities of teachers increasingly enhanced. The resolution required support to be increased for normal universities and colleges, where the system of teacher education based on normal universities and colleges with the cooperation of high-level comprehensive universities need to be established, and cooperative education among local governments, higher institutes, primary and secondary schools need to be promoted. The resolution required standards for the construction of normal universities and colleges to be researched and established with the standards for the majors of teacher training. In addition, the resolution required the policies of free education for normal university students to be improved and perfected, as well as professional accreditation for teacher training developed to ensure the qualities of teacher education. A number of aspects of the policies are directly relevant to the adoption of virtual reality.

Teacher Education Excellence Framework 2.0 was proposed by the Ministry of Education in 2018. The framework required universities and colleges as well as majors of teacher education to enhance the education of teachers' professional ethics, to update the system of curriculum and teaching contents of teacher education, to promote learner centeredness of teacher education, to enhance the quality of practical teaching, to improve the mechanism of collaborative training, to optimize the teaching staff of teacher education, and to improve the quality of teacher education. The framework aims to enhance the comprehensive qualities, the level of professionalism and innovative abilities of learners in teacher education and lay a solid foundation of the training and cultivation of millions of backbone teachers, hundreds of thousands of excellent teachers and tens of thousands of expert teachers. It also aimed to deepen the promotion and application of information technology to teaching reform. The framework required comprehensive integration of the new technology such as Artificial Intelligence and Smart Learning Environments with the curriculum of teacher education, to make full use of virtual reality (VR), augmented reality (AR) and mixed reality (MR), and to develop curriculum resources for teacher education with interactivity and contextuality.

Another policy, the National Action Plan for the Revitalization of Teacher Education (2018-2022), was issued by the Ministry of Education together with the other four administrative departments in 2018. The action plan called for feasible measures to enhance and perfect teacher education, to promote the reform and development of teacher education, comprehensively enhance teachers' qualities and abilities, and to build up a highly qualified, specialized, and innovative teaching staff. This action plan, similar to Teacher Education Excellence Framework 2.0, requires higher institutes of teacher education to improve the system of teacher training, to perfect the contents and ways of

teacher training, and to enhance comprehensive qualities, professional expertise, and innovative abilities of teachers. It has addressed that normal universities and colleges need to play key roles in teacher education and enhance the construction of the system of teacher education to generate innovate the models of teacher education and train outstanding teachers of future generations. The National Action Plan also called for the creative action of "Online Teacher Education" to take full advantage of the Information Technology of cloud computing, big data, virtual reality, artificial intelligence, and to promote the construction and implementation of the platform of educational informatization and the innovation of the teaching methods with the main characteristic of autonomy, cooperation, and exploration. Thus, it requires to initiate the program of construction of online course of teacher education, consisting of the selection and accreditation of 200 national top-quality online courses of teacher education, and the promotion of the wide use and the share of online courses. The proposal of promoting practical abilities to use information technology for teachers and to apply modern information technology in teaching and management for the head teachers in primary and secondary schools has addressed the ability criteria of the technology application and the enhanced standard of the technology literacy among teachers.

The main goals of China Education Modernization 2035 are to build a modern education system of lifelong learning, to enhance universal quality of preschool education, to realize quality and balanced compulsory education, to enhance vocational education, to promote the competitiveness of higher education, to provide special schooling for the disabled, and to form a new pattern of education governance with the participation of the whole society. Furthermore, it sets the direction for the development of the education sector so that its overall capacity and international influence are strengthened. It proposed that the overall goal of promoting the modernization of education is to strengthen the overall capacity and international influence and on top of that, after 15 years of efforts, by 2035, the overall modernization of education will be achieved and China will step into the ranks of educational powers, and become a powerhouse in terms of education, human resources and talents which will lay a good foundation of building China into a great modern socialist country that is prosperous, strong, democratic, culturally advanced, harmonious, and beautiful by the middle of the century.

In the previous chapters, the results of scoping review and systematic review have suggested that there is a lack of evidence about pre-service teachers' beliefs on cutting-edge technologies, such as virtual reality. This is a challenge for educational policies in China, such as the National Action Plan for the Revitalization of Teacher Education (2018-2022) and the Education Informatization Thirteen-Five-Year Plan which aim to move the quality of teacher education and the significance of technology in education forward. Therefore, in this chapter, an empirical study on pre-service teachers' beliefs and training needs on the educational use of virtual reality was conducted to fill this research gap and move the literature forward. This empirical research aims to explore pre-service English teachers' perception of VR technology and their training needs in China, by investigating the status quo of ICT use in the classroom and the potential implementation of VR in teaching and learning. As the main purpose of the study is to understand the beliefs about VR technology for teaching and learning and the training needs for the future use, a mixed-method data collection and data analysis can best examine the relationships and outcomes between different sources of

data (Creswell & Creswell, 2017), and reach a deeper and more comprehensive understanding of the data gathered (Teddlie & Tashakkori, 2009).

This piece of empirical research adopts both interpretivist and pragmatist perspectives although mixed-method research is often associated with a pragmatist worldview (Creswell & Clark, 2017). Interpretivist perspectives are not usually combined with quantitative data, but this has been used in mixed-method research (Gilbert, 2006). The existing theoretical framework in this research shapes the significance of the study by highlighting the interpretation of the research data and the pragmatic nature of the research findings. The interpretive dimension of this study enables the researcher to capture and understand the complex responses from the participants and interpret their intended meaning both independently and in relation to different data sources from the various sources. The pragmatic dimension of the study can offer a perspective aiming to establish "what works" (Morgan, 2007) and guide further actions (Hartas, 2015). It also provides the further insight into pre-service teachers' perceptions of virtual reality technology, the potential of this technology for integration in the classroom, and their perceived training needs for technology implementation in teaching and learning. The combination of interpretivist and pragmatist perspectives, therefore, offers a landscape for interpreting the findings in relation to research questions from the collected data, and by having range of results, addresses the findings of the research to benefit future educational praxis.

The purpose of this empirical study is to identify the perceptions of pre-service English teachers about virtual reality and their perceived training needs in China. It is hoped that this research will provide insights for further ICT training programs for pre-service English teachers' professional development. In order to achieve the aim of this empirical study, the following research questions are articulated:

1) What is the status quo of ICT use and ICT adoption reported by pre-service English teachers?
2) What are the pre-service teachers' beliefs in relation to virtual reality technology for teaching and learning?
3) What are the pre-service teachers' perceived ICT and virtual reality training needs?

Three instruments were developed to measure the research aim and answer the research questions: The Pre-Service Teachers' Perceptions on Virtual Reality and ICT Training Needs Questionnaire, the semi-structured interview on VR in future teaching and learning and VR training needs, and the classroom observation on the status quo of ICT use. The instruments of the measurement were inspired by and further developed from previous research on the evidence of teachers' beliefs on ICT and VR especially. Table 16 explains how the research design aligns with research questions and it shows an overview of how different types of data collected can answer different research questions in this study.

Research Method: Mixed Methods Research Design: Cross-Sectional Design Instruments: Pre-Service Teachers' Perceptions on Virtual Reality and ICT Training Needs Questionnaire Classroom Observation Form Semi-structured Interview		
Research Question	Data Collection	Data Analysis
1) What is the status quo of ICT use and ICT adoption reported by pre-service English teachers?	Classroom Observation Form	Descriptive Analysis

2) What are the pre-service teachers' beliefs in relation to virtual reality technology in teaching and learning?	Questionnaire Section 2 Interview Question	Descriptive Analysis Thematic Analysis
3) What are the pre-service teachers' perceived ICT and virtual reality training needs?	Questionnaire Section 3 Interview Question	Descriptive Analysis Thematic Analysis

Table 16. Empirical Study Research Design Overview

5.2 Instruments

5.2.1 Questionnaire

The use of a questionnaire was the main tool for data collection. The questionnaire aimed to investigate different facets of pre-service English teachers' VR beliefs and ICT training needs. Based on the previous research (e.g. Davis, 1989; Deng, Chai, Chin-Chung, & Min-Hsien, 2014; Giavrimis, Giossi, & Papastamatis, 2011; C. Huang, 2014; Kalogiannakis, 2010; Mahmood & Ajmal Khan, 2007), the Pre-Service Teachers' Perceptions on Virtual Reality and ICT Training Needs Questionnaire (see Appendix II) was developed according to three subject axes. The first axis refers to the background information of participants, such as the year of study, gender, age, technology access and general ICT training experience. The second axis refers to VR beliefs in language learning and teaching, including the subsections of openness to new ICT tools, perceived usefulness, perceived ease of use, and technology complexity. The third axis includes their perceived ICT training needs, including attitudes to ICT and ICT training, reasons for ICT training, expectations of ICT training, and preference for ICT training. All questions in the second and third axis are based on a five-point Likert scale ranging from strongly disagree=1, disagree=2, neutral (neither agree nor disagree) =3, agree=4 to strongly agree=5. The consent form on the welcome page was included in the online questionnaire as well. Both QR code for the online questionnaire and hard copies of questionnaires were provided for participants in case of different contingencies. The overview of the questionnaire is listed in the Table 17.

Section	Subsection	Number of Items
Welcome Page		
Section 1: Background Information		9
Section 2: VR Beliefs in Language Learning and Teaching	Openness to New ICT Tools	4
	Perceived Usefulness	4
	Perceived Ease of Use	4
	Technological Complexity	4
Section 3: ICT Training Needs	Attitudes to ICT and ICT Training	8
	Reasons for ICT Training	8
	Expectations of ICT Training	6
	Preference of ICT Training	8
Thank You Page		

Table 17. The Overview of Pre-Service Teachers' Perceptions on Virtual Reality and ICT Training Needs Questionnaire

5.2.2 Classroom Observation

The method of observation can offer the researcher the opportunity to collect "live" data from naturally occurring social situations on site (Cohen, Manion, & Morrison, 2017, p. 396) and provide knowledge of the real-life context and behavior (Merriam, 1998, p. 96). Particularly, in this research, classroom observations can provide the "live" evidence of pre-service teachers' points of view on their willingness and proficiency using ICT tools in the teaching process. A structured, non-participant observation approach was adopted for the purpose of this data collection process. As pre-service teachers of English, participants observed their own teachers' classes and answered three questions from the Classroom Observation Form:

1) What kind of ICT tools did the teacher use in the classroom and how did the teacher use the ICT tools for the instruction?

2) Do you think the ICT tools used in the classroom have served the purpose of instruction and how did the tools make teaching more effective?

3) What kind of ICT tools will you use in this session to serve the teaching objectives? And how will you use these ICT tools?

Each participant only observed one class, with multiple observations of the same classes. The classes that the participants observed included English Writing, American Literature, Advanced English, English Linguistics, and English Teaching Practice. At the same time, field notes were jotted down by the researcher in-class and as a reference for the observation sessions. The field notes include the date, class code, the ICT tools used in the classroom and students' reaction to the use of ICT tools, which can provide reliable sources and evidence for the follow-up research analysis.

5.2.3 Interview

A semi-structured interview can be tailored to each individual (Gray, 2013; Robson & McCartan, 2016) to ensure that the interview process remains respondent driven and focused (Cohen et al., 2017). It is suggested that the interview process should be long enough for participants to be expressed and explored in depth, and the methods of internal validation such as clarifying or expand on interview responses, rephrasing the question to check for consistency, remaining responsive to the answers, and highlighting the discrepancies in the findings (Arksey & Knight, 1999). The interview in this research was designed for a 20-minute briefing on the VR device and the experience on three VR applications, along with 20 minutes answering interview questions, which is altogether around 40 minutes long. The interview was recorded, with permission, to provide a focused environment for the data collection process (Bassey, 1999; Cohen et al., 2017). Also, the interview questions (see Appendix III) and interview prompts were adjusted by the classroom observation and field notes to gain a more personal dimension and more context-oriented response, on the basis of the interview protocol.

The interview protocol was designed to guide the interview process and it included five steps. Participants were invited to experience three VR applications during the interview and each experience is around three minutes. The first step in the protocol was a general introduction to the participants, such as the aim of the research, the instructions of the headset and types of VR headsets. In the second step, interviewees were encouraged to experience the application of Welcome to Virtual Reality in the headset even if they had experienced VR before. After the initial experience, two questions would be asked relating to the feelings of the experience and the preference of the device types for personal use and classroom use. In the third step, the participants were asked to choose one application (Chemistry VR or Body VR) to experience a VR application for teaching and learning, then interviewees were asked to answer two questions relating to their perceptions on the virtual reality technology application and its potential for teaching and learning. In the fourth step, the language learning app Mondly was demonstrated via verbal description and interface demonstration instead of the normal demonstration procedure because of the issue of the Internet connection for speech recognition. After the description and simple

demonstration, participants were asked their expectations of virtual reality technology and what it could bring to the teaching content and teaching practice. Step 5 was the discussion of the teachers' training needs for virtual reality technology implementation in the classroom. The final step was the acknowledgements of the contribution for participants. The outline of interview protocol is presented in Table 18.

Interview Steps	Contents / Interview Questions
Step 1 - Introduction: General Information (5 min)	The Aim of the Research, Oculus Go Instructions, and Types of VR Headsets
Step 2 - VR Experience 0: Welcome to Virtual Reality (10 min)	1. Have you ever experienced virtual reality technology and how do you think of that? 2. What kind of virtual reality equipment do you prefer for personal use and classroom use?
Step 3 - VR Experience 1: Chemistry VR or Body VR (3 min)	3. How do you see virtual reality technology as a teaching and learning environment? 4. What aspects do you see virtual reality technology as a potential popular tool in teaching and learning?
Step 4 - VR Experience 2: Language App Mondly (Verbal Description and Interface Demonstration) (3 min)	5. What do you expect from virtual reality for English language teaching in terms of the contents? / How will you use virtual reality technology for English language teaching? 6. What do you expect from virtual reality technology in order to complement your teaching practice? 7. Any aspects that will hamper you implementing virtual reality in the classroom?
Step 5 - VR Training Needs	8. Do you think you need to be trained to use virtual reality in the classroom? 9. If you need training for implementing virtual reality in the classroom, what kind of training do you want to receive?
Step 6 - Interview Conclusion	Acknowledge of the Contribution

Table 18. The Interview Protocol

5.3 Data Collection

5.3.1 Settings and Participants

This study focuses on the pre-service English teachers' perception in relation to virtual reality in teaching and learning as well as their perceived ICT and VR training needs in China. Therefore, higher education institutions, especially normal universities or comprehensive universities with teacher education programs were considered for inclusion in the study. The population of the study is all pre-service English teachers in China, but due to the purpose of the study, the research sites and research participants were selected and identified by following these guidelines:

1) The universities for the purpose of research are in, or near, the municipality, such as Beijing, Shanghai, and Guangzhou, or in the capital of provinces. Since ICT tools and devices in these universities and in these cities are well served for English teaching and learning, departments at universities in these cities were more likely to be interested in the research area.

2) Pre-service English teachers from comprehensive universities and normal universities with teacher training programmes or degrees were taken into consideration into the data collection procedure.

3) The pre-service teachers from the English Education Department are aware of the importance of ICT and ICT adoption in teaching and learning, either by participating in earlier initiatives or through their own efforts developing ICT literacy and skills because teachers with prior exposure to ICT training program and were therefore more likely to be interested in the research.

A purposive sampling strategy was employed in this research. Before conducting the research, the researcher emailed and called the administrators or the headteachers of the departments at universities, explained the

purposes of the study and invited the pre-service teachers in the department to participate. Ten universities were identified and invited to the research project by email or by phone, but only five universities were accepted and agreed to participate in the research. The main reasons for refusing to participate in the research include 1) the headteacher was on holiday; 2) the administrator of the department was not available; 3) students were too busy with the final exams; 4) there was no response to email and phone calls. The names of the universities included in this study have been anonymized to protect the privacy of the participants and institutions. The characteristics of the settings included in this study are shown in Table 19.

University ID	University Type	Course	Location
1	Normal University	English Writing	Beijing
2	Comprehensive University	American Literature	Beijing
3	Normal University	English Linguistics	Beijing
4	Normal University	English Speaking	Changsha
5	Normal University	Advanced English	Guangzhou

Table 19. Characteristics of the Settings Included in the Study

5.3.2 Pilot Study

A pilot study was conducted before the formal data collection process. It aimed to test the adequacy of the research design and data collection instruments, as well as to estimate the approximate duration of data collection process. The pilot study involved spending a week to review the adequacy of the questionnaire and teaching observation form to ascertain pre-service English teachers' ICT beliefs and attitudes toward virtual reality as well as the status quo of ICT adoption by pre-service English teachers. It also involved a semi-structured interview to test the process of interview questions and the VR experience. The pilot study was conducted and there were several implications for the final conduction of the research and the data collection process. For example, after the pilot study, it was found that before the data collection, there was no need to print the consent forms for participants to sign; instead, the consent form could be integrated into the welcome page of the online questionnaire so that participants could consent the data collection process and be ready to contribute to the research. Also, the interview process was rearranged from experiencing all the applications in Oculus Go device at once to experiencing the VR technology throughout the interview, which could make the interview more informal and relaxed. The pilot, also the first interview, was conducted in English, but the interviewees couldn't express the feelings freely and were struggling with answering the interview questions in English, so the language used in the interview was changed from English to Chinese. During the interview process, efforts needed to be made to interpret the interview questions in Chinese instead of just translating the questions directly to help the interviewees understand the questions better. The application Welcome to Virtual Reality was provided to the participants in the interview no matter whether the interviewer has experienced virtual reality technology or not, which lasted for 10 minutes. It was also indicated that the numbers of responses to the Classroom Observation Form may be less than the responses to the Pre-Service Teachers' Perceptions on Virtual Reality and ICT Training Needs Questionnaire. In summary, decisions were taken on the minor adjustments to the instruments for the final data collection. Therefore, the result of the pilot study was included in the final process of data collection and data analysis for this research.

5.3.3 Procedures

The participants were informed that three components were included in the data collection procedure, the online questionnaire, the online classroom observation form, and the semi-structured interview. Data was collected between December 2018 and January 2019. To minimize the impact on the classroom instruction during the data collection process, the researcher introduced the aim of the research and provided QR codes for the online questionnaire and the online observation form before the class and suggested the participants to respond to the questionnaire before the class and respond to the observation form after the class. Participants were directed to the questionnaire and the observation form links after the scanning of the QR codes. The hard copies of the questionnaires and observation forms were provided if participants encountered technical issues during the response. The questionnaire was estimated to be able to be completed in between three to five minutes and the observation form was estimated to take two minutes. Participants were given the options to save the response progress or save the QR codes and complete it later so that participants were given flexibility in responding to the questionnaires and the observation forms before the end of the data collection process, i.e., 31 January 2019. After the class, the researcher invited participants to take part in the interview process either with or without prior experience of virtual reality technology. Any participants willing to participate in the interview process needed to register their willingness on the interview registration sheet, so the researcher was able to notify the participants the interview date, time, and location after the interview registration. The procedures of the data collection are illustrated in Figure 6 and the sample details in data collection process are demonstrated in Table 20.

Figure 6. Data Collection Procedures

Steps	Instructions	Participants
Step 1: Questionnaire (Before the Class)	The researcher introduced the aim of the research and provided QR codes for the online questionnaire and the online observation form before the class. Participants completed the online consent form and the online questionnaire before the class.	299 English Pre-service Teachers from Year 1 to Year 4 4 Universities 5 Classes
Step 2: Observation Form (After the Class)	To minimize the impact on classroom instruction, participants were requested to respond to the observation form after the class.	299 English Pre-service Teachers from Year 1 to Year 4
Step 3: Semi-structured Interview and VR experience (After the Class)	When the researcher introduced the aim of the research before the class, participants were asked to provide their contact details if they were willing to participate in a follow-up interview. The interview was then arranged after the class.	23 English Pre-service Teachers from Year 2 to Year 4 4 Universities

Table 20. The Steps and Sample Details in Data Collection Process

Before the interview, participants were advised to allow 40 minutes for the interview, but they could leave the interview earlier if needed. Six steps were included in the interview process, as outlined above: The Interview Introduction, the VR Experience 0: Welcome to Virtual Reality, the VR Experience 1: Chemistry VR or Body VR, the VR Experience 2: Language App, the VR Training Needs, and the Interview Conclusion. The general information introduction included the notification of research aims, Oculus Go instructions, the explanation of types of VR headsets, and mutual agreement of the interview. The virtual reality application simulation experience lasted from

three minutes to ten minutes so participants could immerse themselves to the virtual reality and take a rest from the interview process. Because of the issue of Internet connection of the VR headset during the interview process, the researcher used verbal description and interface demonstration in the VR Experience 2: Language App. The interview conclusion, as the last stage of data collection process, acknowledged the participation and contribution to the research project. More detailed information of interview procedures and the components of interview prompts for the interview protocol is shown in the Table 21.

Step 1 - Interview Introduction: General Information	
Research Aims	Hi! Thanks for participating in the interview! My doctoral research is about pre-service perception on virtual reality technology and the training needs, and this interview is mainly about your opinions on the virtual reality technology, its application in teaching and learning, as well as the training needs of virtual reality technology.
Oculus Go Instructions	Virtual reality is an immersive experience that can be intense. Frightening, violent or anxiety-provoking content can cause your body to react as if it were real. The contents chosen for this interview have under the review of comfort rating of "comfortable". A comfortable virtual reality experience requires an unimpaired sense of motion and balance. Some people (about 1 in 4000) may have severe dizziness, seizures, eye or muscle twitching or blackouts triggered by light flashes or patterns, and this may occur while watching TV, playing video games, or experiencing virtual reality, even no history of seizures or epilepsy. If you have experienced any of these symptoms before, I would suggest you consult your doctor before participating in this interview. You should immediately discontinue using the headset if any of the following symptoms are experienced: seizures, loss of awareness; eye strain; eye or muscle twitching; involuntary movements; alerted, blurred, or double vision or other visual abnormalities; dizziness; disorientation; impaired balance; impaired hand-eye coordination; excessive sweating; increased salivation; nausea; lightheadedness; discomfort or pain the head or eyes; drowsiness; fatigue; or any symptoms to motion sickness. Just as with the symptoms you may experience after the disembark a cruise ship, symptoms of virtual reality exposure can persist and become more apparent hours after use. These post-use symptoms can include the symptoms above, as well as excessive drowsiness and decreased ability to multi-task. These symptoms may put you at an increased risk of injury when engaging in normal activities in the real world. To reduce the risk of discomfort, properly adjust side and top straps, and ensure comfortable placement of the facial interface and that you see a single, clear image; this will aid in proper weight balance and distribution of the headset. I will help you to recheck the settings before resuming use after each break, to avoid any unintended changes to any adjustments. The headset produces an immersive virtual reality experience that distracts you from and completely blocks your view of your actual surroundings. Always be aware of your surroundings before beginning use and while using the headset. Use caution to avoid injury. Remember that the objects you see in the virtual environment do not exist in the real world, so don't sit or stand on them or use them for support. Use the headset with glasses may increase the risk of facial injury if you fall or hit your face, and I will install a pad in the device so it will prevent the contact between the lens and glasses. During the experience, please remain seated and make sure you are seated on a secure surface and stable platform. Ease into the use of the headset to allow your body to adjust; use for only a few minutes at a time at first, and only increase the amount of time using the headset gradually as you grow accustomed to virtual reality. Looking around and using the input device when first entering virtual reality can help you adjust to any small differences between your real-world movements and the resulting virtual reality experience. It is normal for your headset to feel warm to the touch while in use. Prolonged skin contacts with a headset that is hot to the touch may produce skin discomfort or redness, or low temperature burns. If you feel hot to the touch or is uncomfortably warm, stop using it and allow it to cool down. You can share the feelings about using VR technology and how will you use that in your teaching. Now, I will introduce this device to you that we'll use next. This is a portable virtual reality headset: Oculus Go. Every charge would last for 2 hours of use. The resolution of this device is 2560*1440. It is important to use the lanyard to secure the controller on your wrist. You can use the controller to scroll and track like a touchpad. The backspace and home button are on the controller as well. You need to recalibrate your screen by hold the Home key and release it after you wear the headset. (Note: Some of the instructions were adopted from Oculus Go Safety and Warranty Manual)
Types of VR Headsets	There are mainly three kinds of virtual reality headsets available in the market: tethered VR, smartphone VR, and standalone VR. Tethered virtual reality headsets, such as Oculus Rift and HTC VIVE Pro, are the most expensive but much more immersive than other types of VR due to the high-quality experience they can deliver. These premium VR devices require a certain amount of setup space as well as a constant cable

	physically connected and powered by a high-performance computer. Smartphone VR, such as Google Cardboard and Samsung Gear VR, it requires a smartphone, but are often made of low-cost materials. Limited VR experiences via a smartphone can be provided and the quality of VR experience depends on the smartphone being used. Standalone VR, such Oculus Go, has built-in processors, sensors, battery, storage memory, and displays, and this is why users refer it as all-in-one VR headset because it doesn't require a connection to a PC or a smartphone. The reason why we use Oculus Go for this interview is that standalone VR devices are more affordable and dynamic, and it is portable as well.
Mutual Agreement	If you think you have understood what I have said have no problems with that, we will start our interview process. Should you have further questions, let me know as soon as possible. Thanks for the cooperation!
Step 2 - VR Experience 0: Welcome to Virtual Reality (10 min)	
	This experience is for participants who have never experienced VR before. You are still welcome to try this app out if you have experienced the VR before.
Step 3 - VR Experience 1: Chemistry VR or Body VR (3 min)	
	You can choose one application from these two VR demonstrations. The Chemistry VR is about the demonstration of the structure and component of an atom, and the Body VR is about the demonstration of blood vessels.
Step 4 - VR Experience 2: Language App (Verbal Description and Interface Demonstration) (3 min)	
	This Language App Mondly is the only multi-language learning application for Oculus Go at the moment but unfortunately due to the issue of Internet connection, we could not use this app for the demonstration. However, I can describe to you how this application works, and you can take a look at the application interface. Mondly can provide multiple language learning environments, such as dining in a restaurant, checking in a hotel, taking a taxi and so on. And you'll get instant feedback on your pronunciation, suggestions that enrich your vocabulary and surprises that transform learning a language with a unique experience. You could also watch this video to get to know this language learning app.
Step 5 - VR Training Needs	
	Do you think you need to be trained to use virtual reality in your English language teaching classroom? This could not just refer to the VR technology itself, but you could relate the training needs to the setup of the curriculum or other aspects. If you need training for implementing virtual reality in the classroom, what kind of training do you want to receive?
Step 6 - Interview Conclusion	
	Thanks for participating and contribute to the research project. If you have anything to add to the interview, please let me know. Thank you for your time and contribution.

Table 21. The Interview Procedures

5.3.4 Validity and Reliability

The consideration of the validity of this study relies on its internal validity – the establishment of the agreement among different parts of the data, the demonstration of the transparent interpretation of the data, and the acknowledgements of the inconsistent findings, along with the construct validity – the reflection of the actual experience and the interpretation of the situations in the research (Cohen et al., 2017). Also, the evidence chain in this research provides systematic documentation of the research process, accurate transcription of the data, transparent illustration of data analysis process, and reflective interpretation of the researcher's role in the study (Yin, 2003). Quantitative and qualitative data from pre-service teachers were analyzed in the research concurrently to triangulate findings (Gay, Mills, & Airasian, 2011) including the Pre-Service Teachers' Perceptions on Virtual Reality and ICT Training Needs Questionnaire, Classroom Observation Form, semi-structured interview, and field notes. The triangulation of data collection across multiple methods, sources, and modes of evidence can strengthen the validity by developing "a more complex, context-respecting set of explanations" (Miles & Huberman, 1994, p. 267), and the mixed methods study can present a unique range of legitimate concerns of validity (Onwuegbuzie & Johnson, 2006). Although this study does not intend to measure the large-scale generalization, i.e., the measurement of external validity, the consistency and accuracy of replicability and transparency of the research can still provide replicable research models for future research.

5.3.5 Ethical Considerations

Both quantitative and qualitative data were collected in this research and important ethical considerations were taken into account in line with the Ethical Guidelines for Educational Research (2018). The aim of the ethical considerations is to ensure no harm that will befall participants. Before conducting this phase of the research, the Ethics Application Form was completed and approved by the School of Education's Research Ethics Committee. The empirical study started after the ethical approval has been obtained. Before conducting the research, the researcher emailed or called the headteachers or administrators of English education department at universities, explained the purpose of the study and invited the pre-service teachers in the department to participate. All participants were notified with a clear statement of the purpose of the research and asked to agree with Consent Form (see Appendix IV) before the participation. Participants were advised that participation was voluntary and that they could withdraw at any time without penalty. The importance of the need for the researcher to respect and protect the confidentiality of the participants was also addressed (e.g., Denscombe, 2017; Singer, 2008). Participants were made aware of the confidentiality protection that any identification of the participants were anonymized; the questionnaire data, observation data, and interview data would not be revealed and shared to others and were kept private and untraceable in a password protected laptop solely used for the research purpose.

Another fundamental principle that underpins the ethical considerations is that the researcher must always consider the welfare of the participants and protect them from being either physically or mentally harmed in the research (Hammersley, 2009). Overall, the risk of harm to the participants was very low as the research did not seek to change the educational experience of the participants who were mostly asked to respond to a questionnaire and provide their perspectives on ICT use in education (Brooks, Te Riele, & Maguire, 2014). For the VR interviewees there were additional considerations resulting from the technology (which can cause minor discomfort, such as nausea or dizziness). It was also important to ensure the room was set up so as to mimimise any risk of falls resulting from any disorientation. All participants were informed of verbally of the procedure and what to do if they experienced any discomfort. Wider issues arising from VR adoption were not considered relevant to this research as the exposure to the technology was extremely short (Spiegel, 2018). Also, the research reported in any future publications will keep the anonymity of the participation in this study. Appropriate data protection regulations were followed in accordance with the requirements for research students at Durham University.

5.3.6 Data Management Plan

The value of the research data is being increasingly recognized since it plays a key role of the outcomes of the research by various stakeholders, such as academia, sponsor, and publishers. Having a data management plan (DMP) to describe how the researcher will treat the data during the research and the considerations on the data reuse after the research can help future researchers extract maximum benefit from these research investments. The DMP typically covers every or a portion of the data life cycle, including but not limited to the identification of administrative data, the data collection process, documentation and metadata, data quality assurance, ethics and legal compliance, data storage and backup, data selection and curation strategy, data policy, data dissemination, as well as responsibilities and resources. Michener (2015) presented ten simple rules for an effective DMP to help the

researchers maximize the return on the project investment. The guidance includes the following rules: 1) Determine the requirements of research sponsors; 2) Identify the types, sources, volume, file formats of the data to be collected; 3) Define the details of management of the data to be generated; 4) Explain the documentation of the data and metadata standard; 5) Describe the data quality assurance; 6) Present the data storage, backup and preservation strategy; 7) Define the data sharing policies; 8) Describe the ways of data dissemination; 9) Assign roles and responsibilities associated with the project; and 10) Prepare a budget justification for the project.

Since all the research needs to be transparent, reproducible, and reusable in every aspect of the research process where feasible, Wilkinson et al. (2016) proposed the FAIR Data Principles – Findability, Accessibility, Interoperability, and Reusability – a measurable and brief and set of principles to enhance and maximize the benefit the added value of contemporary scholarly publications. FAIRness could be interpreted as 1) data should be described with metadata and indexed in an identifiable and searchable resource; 2) metadata is accessible and retrievable by using an open, standardized protocol; 3) the metadata use widely applicable language for knowledge interpretation and reference to other metadata; and 4) metadata is associate with rich description, detail provenance. However, the guidelines are not a specification or a standard. Rather, they help the data publishers and stakeholders to evaluate whether the digital research artifacts are FAIR. In this study, the types of data include survey data and audio recordings. Survey data was created online and interview recording data was created by Windows 10 Application Voice Recorder. SPSS was used for questionnaire data analysis and NVivo was used for interview and observation data analysis. The research records were stored securely in a password-protected Windows 10 laptop and only the researcher has access to the records. The researcher himself is responsible for data collection and data storage. All data was anonymized. After the interview transcription and checking, audio recordings were deleted for anonymity. Data was stored securely in a password-protected Windows 10 laptop and the data is backed up to OneDrive under Durham University email account. The data will be destroyed securely after five years once the findings of the study are written up, and the data will not be shared. More detailed information relating to research data management and data protection please see Data Management Plan, Date Protection Privacy Notice and Debriefing Sheet in Appendix V and Appendix VI.

5.4 Data Analysis

The five-point Likert scale questions were evaluated and analyzed with descriptive statistical analysis using SPSS 26. All other qualitative data was imported into QSR NVivo 11 for thematic analysis (Braun & Clarke, 2006). The interview recordings were transcribed into NVivo for coding with audio files accompanying the transcripts. The observation data and other documents will be added as external resources in the same NVivo project file. The researcher as the only translator of the transcripts, and the combination of various evaluation approaches such as checking for comprehension, testing for readability and compare the translation consistency, can maximize the reliability and credibility of the study (Esposito, 2001; Twinn, 1997).

Themes were generated after coding several samples of the interview transcripts and field notes. The initial analysis of the pilot interviews generated the potential themes from the transcripts, and the identification of the codes was

modified by adding new ones to generate consistent, integrated, and plausible analysis of the qualitative data (Glaser, Strauss, & Strutzel, 1968), since the codes and categories identification is a joint process of the exploring the characteristics of the data collected (Lune & Berg, 2017). For instance, when analysing the seventh question in the interview "Any aspects that will hamper you implementing virtual reality in the classroom?", the pilot phase of the analysis didn't include the theme of the storage and maintenance of virtual reality devices, so it was identified and added to the existing themes in NVivo project. Two stages of coding were involved in the thematic analysis of the interview transcripts, the initial coding and then focused coding (Charmaz, 2014). The initial coding included more general categorization of the transcripts (the dimensions of the measurement of pre-service teachers' beliefs and training needs, e.g., the dimension of 'Previous Experience of Virtual Reality') and the development of provisional codes (e.g., the potential effectiveness of virtual reality in teaching and learning under the dimension of Potential Reasons for Popularity) to help the analytical direction, while retaining some flexibility in the coding process. Focused coding moved beyond these descriptive categories to identify patterns for breadth of the analysis by considering the associations between the categories and codes as well as the importance of analysing participants themselves (Cohen, 2018; Maxwell, 2012). The themes were then summarised in relation to the questions posed in the interviews to provide a structure for the analysis and findings.

5.5 Findings

5.5.1 Overview

This study investigated the pre-service English teachers' perception in relation to virtual reality in teaching and learning as well as their perceived ICT and VR training needs in China. Altogether, 299 questionnaires and 127 observation forms (approximately 25 per class) were collected, and 23 semi-structured interviews were conducted. Descriptive statistical analysis and thematic analysis were used to answer the following three research questions:

1) What is the status quo of ICT use and ICT adoption reported by pre-service English teachers?
2) What are the pre-service teachers' beliefs in relation to virtual reality technology for teaching and learning?
3) What are the pre-service teachers' perceived ICT and virtual reality training needs?

The collected background information in the first section of Pre-Service Teachers' Perceptions on Virtual Reality and ICT Training Needs Questionnaire included demographic information (year, gender, age, devices access), intention of using educational software or hardware in the teaching practice, top three technologies in classroom integration, the status of ICT training courses attendance, location and topics of received ICT training courses, and the status of previous virtual reality experience. The demographic information presented in the Table 22 has shown that most of the participants were from second (34.4%) and third year (50.8%). Of the 299 respondents, 23 were male and 276 were female. The age of the participants varied from 17 to 28. The majority of the participants (95.7%) have access to mobile phone, most of the participants have access to laptop (67.9%), more than a half of the participants have access to desktop computer, and more than a third of the respondents can access to tablet or iPad. However, only 8 percent of the participants have access to virtual reality headset. 232 participants (77.6%) believed that they will use any educational software or hardware in the teaching practice, in which, the top three technologies they would like

to use most were office suite, computer and mobile phone. Nearly eighty percent (n=238) of the respondents had never attended ICT training courses in the past. For those who have attended ICT training courses in the past (n=61), the training courses were mostly organized or supervised by their colleges or departments. Additionally, 60% of the participants (n=180) had experienced virtual reality before while 40% of the participants (n=119) had never experienced virtual reality technology.

	Frequency	Percentage
Year		
1	1	0.03
2	103	34.4
3	152	50.8
4	43	14.4
Gender		
Male	23	7.7
Female	276	92.3
Access to Devices		
Desktop Computer	158	52.8
Laptop	203	67.9
Mobile Phone	286	95.7
Tablet/iPad	99	33.1
Virtual Reality Headset	24	8
Total Respondents	299	

Table 22. Demographic Information

5.5.2 Research Question 1

Research Question 1: What is the status quo of ICT use and ICT adoption reported by pre-service English teachers?
Data Source: Classroom Observation Form

Table 23. Research Question 1 Overview

In the Classroom Observation Form, three questions were addressed to answer the first research question: 1) What kind of ICT tools did the teacher use in the classroom and how did the teacher use the ICT tools for the instruction? 2) Do you think the ICT tools used in the classroom have served the purpose of instruction and how did the tools make teaching more effective? 3) What kind of ICT tools will you use in this session to serve the teaching objectives? And how will you use these ICT tools?

Most of the participants in the observation have noted that the technology tools such as PowerPoint, computers, projectors were mostly used in the classroom instruction for the replacement of the use of traditional blackboard and chalk. Also, the interactive whiteboard was mentioned in the current technology integration in the classroom. In addition, participants expressed various opinions on whether the ICT tools used in the classroom have served the purpose of instruction and how did the tools make teaching more effective. The majority of the respondents affirmed the positive effect on the technology tools used to serve the purpose of instruction and to make teaching more effective, reasons including 1) the technology tools can provide more vivid and demonstrate interesting information to students, 2) the combination of different sensations, such as listening and viewing, can help students memorize and understand the knowledge better, 3) it would be time-saving for teachers to demonstrate the slides instead of writing the knowledge points down on the blackboard, 4) the use of technology can make teaching

demonstrations much clearer, 5) the teacher could use highlighting to remind students to pay attention to the important knowledge points, 6) the use of technology can attract students attention in the learning process, and 7) it is convenient both for teachers and students to save, print and revise. However, a few responses explained why the technology tools used in the classroom didn't serve the purpose of instruction and made teaching less effective, such as 1) the overuse of the technology might decrease the value of the textbook, 2) the current technology used in the classroom cannot satisfy all students' learning needs, and 3) we should stay away from technologies and stay as close to nature as possible. Furthermore, when participants were asked how the teaching session could have changed by using different ICT tools and how to use these ICT tools, most of the respondents expressed that they would still use the same technology tools without any change because they thought the combination of PowerPoint and projector would be the perfect partners for classroom instruction, while some respondents mentioned alternative technology tools for more effective classroom integration such as interactive whiteboards, mobile phone, online courses, websites, Internet, iPad, and even virtual reality.

5.5.3 Research Question 2

Research Question 2: What are the pre-service teachers' beliefs in relation to virtual reality technology for teaching and learning?
Data Source: 1) Pre-Service Teachers' Perceptions on Virtual Reality and ICT Training Needs Questionnaire Section 2 [Openness to New ICT Tools] [Perceived Usefulness] [Perceived Ease of Use] [Technological Complexity] 2) Interview Questions 1 to 7

Table 24. Research Question 2 Overview

In order to answer research question two, the second section of Pre-Service Teachers' Perceptions on Virtual Reality and ICT Training Needs Questionnaire and interview questions from 1 to 7 were analyzed by descriptive statistics and thematic analysis. The second section of Pre-Service Teachers' Perceptions on Virtual Reality and ICT Training Needs Questionnaire contains four components, and each component contained four sub questions. Descriptive statistics were used to measure the score of each question on the components of Openness to New ICT Tools, Perceived Usefulness, Perceived Ease of Use, and Technological Complexity. The standard errors were within a narrow range indicating that the spread of responses was similar for each question. Table 25 shows the results for each individual question related to pre-service teachers' beliefs about virtual reality. Most mean value of the items fall into the range of neutral (n=3) to agree (n=4) except the item "15. I think it will be difficult for me to learn how to use virtual reality equipment in language teaching" and item "16. I think it will be hard for me to use virtual reality equipment so that it is aligned to my teaching objectives" that were below but very close to 3 (mean=2.99).

Items	Mean	
	Statistic	Std. Error
[Openness to New ICT Tools]		
1. I like being exposed to new advanced technologies, such as virtual reality.	3.82	.061
2. I like learning with the use of new technologies, platforms and channels in my teaching.	3.94	.060
3. I am aware of the recent development in virtual reality and its application in language teaching.	3.44	.063
4. I look forward to using virtual reality equipment in my future teaching career.	3.89	.063
[Perceived Usefulness]		
5. I think the use of virtual reality in language learning is stimulating and interesting.	3.97	.061
6. I think the use of virtual reality will make my teaching more stimulating and interesting.	3.97	.060
7. I think the use of virtual reality will enhance my effectiveness in language teaching.	3.86	.058

8. I think using virtual reality can assist me to teach students complex language structure.	3.75	.065
[Perceived Ease of Use]		
9. My teaching objectives with virtual reality will be clear and understandable.	3.67	.057
10. I think virtual reality can accomplish the teaching objectives in the classroom.	3.75	.055
11. I think virtual reality equipment is easy to use.	3.37	.061
12. I think it would be easy to handle teaching sessions with virtual reality equipment.	3.42	.058
[Technological Complexity]		
13. Learning to use virtual reality equipment will take up too much of my time.	3.23	.056
14. Using virtual reality equipment in the classroom will involve too much time in lesson planning.	3.31	.055
15. I think it will be difficult for me to learn how to use virtual reality equipment in language teaching.	2.99	.061
16. I think it will be hard for me to use virtual reality equipment so that it is aligned to my teaching objectives.	2.99	.060

Table 25. Descriptive Statistics of Pre-service Teachers' Beliefs about Virtual Reality

The thematic analysis of the interview transcripts was based on seven dimensions to measure pre-service teachers' beliefs about virtual reality: 1) Previous Experience of Virtual Reality, 2) Device Choice for Personal Use and for Classroom Use, 3) Teaching and Learning Environment Outlook in Virtual Reality, 4) Potential Reasons for Popularity, 5) Teaching and Learning Content Outlook in Virtual Reality, 6) Teaching Practice Expectation in Virtual Reality, and 7) Virtual Reality Implementation Obstruction.

[Dimension 1: Previous Experience of Virtual Reality]

More than a half of the participants in the interview stated that they had experienced virtual reality before, either in a research or in a shopping mall:

> "Yes. I've participated in a psychology research. I think this kind of technology is quite good for research purpose. This technology is kind of fresh, to be honest. That device was located at a lab for psychology research purpose. I don't really know the brand of the device, but I remembered I wore a headphone with it. The research was about the effects of two different environments: pleasant and unpleasant to brain memory, and I could hear different music from the earbuds as well. The equipment was desktop-based, and there was some space for the movement. The experience was quite interesting, real and immersive."

> "I have experienced the virtual reality technology before in a shopping mall. It was several years ago and the device at that time was kind of old and outdated. I felt dizzy and the quality of the experience was not that good, so I think that was just the entry level to the experience of virtual reality technology. But just now after I experienced this application in the virtual reality, I think the technology now is more advanced than before and I think the developers are more considerate for the users plus the construction content is quite good and clear. But still the technology now has a room for improvement such as the quality of the video; it could have been more smooth and clearer. By the way I feel a little bit heavy when I was wearing the headset."

For those who have never experienced virtual reality before, participants hold a positive attitude towards the experience of the technology:

> "I haven't experienced it before, but I've heard about it. My impression of virtual reality is quite wonderful. This is a new experiment for the world because virtual reality technology sounds very interesting and exciting. I think the use of virtual reality in teaching can stimulate students' interest because the classroom atmosphere is activated, and students' attention will be focused. I hope this technology can be fully applied to curriculum teaching."

After the experience of the application "Welcome to Virtual Reality" in Oculus Go, several participants have experienced temporary motion sickness but appraised the overall comfort for the experience and incredible visual effect that the technology can bring:

> “I've never experienced that, but I've heard that before, for gaming. After I have experienced this welcome to virtual reality demonstration, I feel it's quite immersive! It is so immersive! And I feel a little bit dizzy when I'm wearing the headset.”

> “I feel very surprised and incredible. I felt so dizzy and uncomfortable when I was first experiencing the virtual reality, but for this device, I don’t feel uncomfortable at all. The technology is advancing, and I am so happy with it. Also, it is quite funny to experience the technology, and it’s also miraculous. When I started the device, there were a lot of cool scenes such as libraries and space travel going on as if two persons were talking with you and it was fun. When I was in the spaceship, I was a little bit nervous. It's like opening up a whole new world and it is wonderful. Sometimes I don't think it's real. I can experience things I've never experienced before. However, it's not the same as when you actually travel to that place, because you're just sitting there passively taking what's given to you, but you cannot communicate to the machine.”

[Dimension 2: Device Choice for Personal Use and for Classroom Use]

When participants were asked what kind of virtual reality equipment they prefer for personal use and classroom use, most of the participants preferred the use of standalone devices only because of the convenience and optimized experience that it can bring:

> “For the classroom use, I would like to choose this kind of portable device: It has high resolution, and easy to carry. The desktop-based VR equipment requires computer or laptop with powerful GPU. The price is high and difficult to install. Although the Samsung Gear VR or Google Cupboard is cheap, the resolution would be too low to use, so the quality of the experience would be compromised. So, the portable VR device like Oculus Go would be suitable for classroom use. Also, it would be inconvenient if there are lots of cables in the classroom, this would be a potential hazard in the teaching process. And with this portable device, students can just sit on the chair and enjoy the learning, so they won’t get tripped by not seeing the hazardous objects outside of the VR. The reason why I don’t use Gear VR is that the poor image quality, even though the price is quite low. Desktop based VR would be a waste of time using in the classroom because it needs students to try the device one by one. Also, teachers need to take care of students’ safety during the headset use.”

> “I would like to use the standalone virtual reality device because it is so convenient. Also, for classroom use I would recommend this kind of device as well because it's just only one device to use in the classroom unlike other two devices, the desktop-based devices require the powerful computer to support the running and the goggles need mobile phones to support the virtual reality application, so standalone device would be the most convenient to use in the classroom and is not too expensive as well. Students are not required to walk around the classroom to learn, so I think this portable device would be suitable for language learning in the classroom.”

Some participants stated that they preferred the desktop-based virtual reality equipment for personal use and the Cupboard virtual reality equipment for classroom use:

> “For myself if I have the money to buy the equipment, I will choose the desktop-based virtual reality headset because it can present the best quality of the virtual reality experience. And if there are accessories with the equipment, I would like to buy them as well. For classroom use, the VR Cupboard would be sufficient for teaching and learning because we don’t really need the best quality and best experience for learning and teaching. The main purpose of using virtual reality technology would be motivating students in their learning process instead of pursuing the best quality and the best experience when using the technology in the classroom. If we need to use the technology widely and expand the usage of virtual reality, we really need to consider the cost effectiveness of the device purchase.”

One participant considered that she might choose mobile phone-based virtual reality equipment for personal use and the desktop-based equipment is not on the choice range anyway:

> “The mobile phone-based device would be more convenient for me because I already have a phone. For classroom use, the standalone devices would be more suitable in teaching and learning, but if students already have mobile phones that are compatible with the gear headset, then the phone-based devices would be more convenient. I think I wouldn’t choose desktop-based VR devices no matter in what kind of circumstances. I don’t like the cable scattering around. It is inconvenient to install and to use as well. For school use, I think I’ll choose the Gear VR because they’re cheap to use. We could buy more devices so that students would have more chance to use them. Students nowadays mostly have their own mobile phones so just provide the VR Gear in the classroom. It’s easy and doable, also money saving as well. All they need to do is install the software in the phone and they’re not restricted to the device or software the school has required to install or to use. They have their own freedom for their own devices use, after the use in the classroom.”

On the contrary, another participant was very focused on the advanced gaming experience but his choice for classroom use was quite rational:

> “I’ve experienced virtual reality technology just once, and I would like to own a device for gaming. High resolution, high grade of color variance, the quality of the lens, powerful CPU, right, the GPU is also important as well... I’m expecting to see a big screen in front out me, either flat screen or cured screen. It will make the movie-watching experience more immersive. I could stream the videos online or from the device, so if I’m watching something from the local device, I may need large storage space for that. For classroom use I think all-in-one device would be the best option because we have technical support to manage the purchase of the device and the use of the device in a classroom, and all in one headset wouldn't need too much time on the device setup.”

Interestingly, some participants suggested that the choice of different equipment should be considered for different situations:

> “For me I would choose the standalone virtual reality device because it doesn't require a specific field to use the device and you can use the device wherever you want, just sit and relax. And I think all-in-one device will be more portable and more convenient for me to use. I think for classroom use the purchase of the virtual reality equipment will depend on the teaching and learning needs. Also, it depends on what kind of devices are available now. For example, if most of the students in my class they have mobile phones that are compatible with the VR Cupboard, then I would choose VR Cupboard because they are easy to use and install. And I think the desktop-based virtual reality headset is not suitable for classroom news because it requires a large space for one person so it wouldn't be applicable to use in the class.”

> “I would like to choose the standalone virtual reality device because it doesn't need additional equipment to support the running of virtual reality applications. The standalone device would be more convenient for classroom use as well because the desktop-based virtual reality device requires a powerful computer and the mobile phone-based virtual reality devices requires additional phones so the standalone device would be quite convenient and cost effective for teaching learning purpose. But if everybody in the classroom has the mobile phone then the mobile phone-based virtual reality may be more suitable for the classroom use.”

[Dimension 3: Teaching and Learning Environment Outlook in Virtual Reality]

When participants were asked how they thought of virtual reality as a future teaching and learning environment, participants expressed their high expectation that the virtual reality can be used in the classrooms:

> “I think the most popular tool we’re currently using in the classroom is PowerPoint. Compared to PowerPoint, it is even more powerful. I can even feel it! It is like I’m a blood cell in a real blood vessel and it’s so immersive! The explanations in the video are clear, professional, and quite memorable. I can concentrate and more focused on the learning content. For me, the passion to learn in the class is largely depending on the teachers,

like the teaching methods or teacher themselves. If I get bored in the classroom, I may lose my motivation to the whole course. So, teachers' way of teaching will influence my learning a lot. Using virtual reality would make the classroom more interesting, and students would love it because it makes the classroom more creative. Also, it makes the course delivery more objective instead of subjective because the learning motivation would not be affected by teachers that much if you're immersed in the virtual reality environment. It just provides a very focusing and concentrating environment for learning."

"I think the use of virtual reality technology is kind of creative and it is quite easy to learn any new knowledge. I still remember that in my biology class in high school teacher even didn't use any of the illustrations or blood pipes to show us how the blood flows in our body. It'll be much more effective than teacher's talk only because this brings you to the world of vessels so just like you live in the vessel and you move as the blood flows. This immersive experience really can help students to learn the knowledge and to experience the knowledge as well. If the price of the virtual reality devices is not too high, then school probably would buy the equipment to help students to better understand the knowledge they need to acquire and help teachers to give better illustrations on the knowledge. Actually, the virtual reality technology itself can motivate students a lot in their learning and with the help of virtuality technology students may retain the knowledge for a longer time. Is this called 'learning by experiencing'?"

However, some participants expressed their doubts and concerns about the integration of the virtual reality technology in the classroom even though they think it is a promising technology to be used in the class:

"When I was experiencing the virtual reality device, I was thinking of these questions: Am I concentrating more when I'm using the virtual reality technology? The answer is yes! So, I think virtual reality technology can bring positive effect to our teaching and learning and I also think this kind of technology could make the knowledge comprehension more easily specially for the conceptual knowledge. And I came up with another question if the video in this virtual reality is transferred to the video just like what we watch on the website, what are the differences I can bring to students learning effectiveness? I'm not clear that whether the 2D video has the same effect with the 3D video and I think teachers need to work on that first. For teachers I think they need to think these questions before they use the virtual reality technology. First, I need to think why we need to use virtual reality technology in the class and are we going to use the technology in the class or after the class and how we use them? Are we going to use the virtual reality technology just for the knowledge teaching or for the purpose of knowledge retention? Can we use virtual reality technology to assess students' learning process like doing exercise after the learning?"

"After I have experienced body VR, I think it would be much more vivid and straightforward to demonstrate the structure of the red cell compared to just teacher's talk, and it reminds me the nature of red blood cell is small, round, and biconcave. Ahh, that is so vivid! So, I am thinking that if the virtual reality technology could be so vivid and so straightforward, so what's the role of the teachers in the future? Are they gonna lose the job? Hmmm, the science teachers may have a chance but for arts and humanities I don't think so, because teachers in arts and humanities, they need to cultivate students thinking ability and their view to the world, and I don't think virtual reality technology can do that to replace teachers. But for science teachers, virtual reality can replace some parts of science demonstration and teacher can just be the guidance while students are experimenting the science demonstration by themselves. So, facing this challenge and the job insecurity, teachers may feel more motivated to dedicate themselves into teaching and learning and contribute their human aspect that the machine doesn't have, the virtual reality technology could not reach or achieve at the moment. Also, it's hard for the machine to conduct a consulting session, it would be a mess! Or teachers may think passively, and they maybe change their career in the future."

And a few participants denied the value of virtual reality technology in the current teaching and learning situations:

"I don't think in my hometown we are going to use this kind of device because the price of the device it's not that affordable in my hometown, but for metropolitans or major cities they may use that for teaching or

learning. Maybe in the future the device would be more affordable and can be widely used in the classroom, then the device can motivate students learning process and move their learning to a next level. Also, I am concerned about the addiction of the virtual reality technology like other technologies, so if students are so addicted to the virtual world, how can we pull the students back to the real world?"

"I felt quite terrified after experiencing the chemistry VR, and I think children and kids will be more terrified, especially for little girls. Because the movement of the object are so fast so you can experience feelings like riding a roller coaster or Bungee Jumping, but I think if students are used to it then it wouldn't be a problem for them. So, at the beginning I think there would be a really big problem for teaching and learning."

Moreover, some participants addressed some issues when implementing virtual reality learning environment in the educational field:

"When virtual reality technology is used as a teaching and learning environment it is very intuitive and specific. When I see a cell, I can see its structure and its shape clearly. In the past, we learned about molecular formulas, chemical structures, and functions without direct perception. When we use virtual reality as assistive tools, I feel like I know a lot of things at once. I think it is amazing. I'm very interested. I think I had a good time with it. It is closely related to the foundation of existing learning. In class, everyone has individual differences in learning. Teachers should teach students in accordance with their aptitude. If the teacher sets the same teaching content, some students simply can't keep up, some students just feel funny, and some students may seek deep understanding. Teachers must therefore take into account the diversity of their students. Some students just go through the learning content, but not involve their own thinking process. If you know what you're learning first, you will have a basic framework for what you want to learn and on the basis of your own understanding, you will understand more. If you don't think ahead, you'll understand less. It is difficult to apply virtual reality to practical teaching to construct students thinking process. It is demanding for teachers to use virtual reality for teaching. Teachers must first be familiar with how to use virtual reality teaching equipment. If a teacher controls a virtual reality teaching device, the students still feel that the teacher is in control of their studies. While virtual reality technology is good for teaching, but I think learners' own learning, thinking process and optimized learning experience are necessary as well."

"I see the flickering in the device. I know that you can see the lights flickering in camera but not in the eyes. The images get blurry from time to time, and it's a little bit heavy for me to wear it. I think the teacher could use this kind of technology partially in the classroom, like introducing a new idea or warm up activity for a new lesson. It'll be more effective to gain students' attraction to the new learning topic. It can provide the strong visual effects for learning but not the sound effects. If the students can wear headphones for this, then they can hear the sounds from their own device not being affected by repetitive sounds from other devices in the same room."

"I think this should be used for a short period of time for instructions, like knowledge demonstration. Teachers should be the main character in the class. I could hear all the energetic sounds and music from the device and that made me feel uncomfortable as a teacher. The construction of the knowledge in the classroom needs to be delivered by the alive teachers, not the machine with all sorts of loud effects. It can provide authentic learning and teaching material, but definitely not the main character in the classroom."

"For STEM subjects and for abstract concepts, traditionally teacher would use pictures models to demonstrate the knowledge, while the use of virtual reality technology could help students to understand in a better way. Also, for knowledge points such as the 3D structure of cells in the biology that you need to use imagination to absorb the knowledge points, and this form of technology would be better for I use our PowerPoint or just blackboard. So, if the design of the application is not that interesting or attractive students may feel bored even if they are wearing the headset. Also, it should satisfy students learning needs and students should be comfortable to use the device in the learning process. Students cannot take notes while they are wearing the headset and they have no idea what's going on outside."

[Dimension 4: Potential Reasons for Popularity]

Most of the participants mentioned the potential effectiveness of virtual reality in teaching and learning so as to gain popularity.

"To popularize virtual reality technology, first it is necessary for the teacher and the students to experience this technology and realize that the virtual reality has the positive effect on teaching. And it is necessary to train teachers and students how to operate virtual reality teaching equipment, adjust the curriculum and maximum the learning effectiveness."

"I think the primary goal of using virtual reality technology is to enhance students' learning and to see the effectiveness of the technology could bring into our learning and teaching. Then we will consider whether virtual reality technology could motivate students learning and make the learning process more vivid and interesting or not. With the use of virtual reality technology teachers don't need to repeat to make students understand the knowledge because the immersive characteristic of the virtual reality technology could save teachers' huge amount of time. In this sense teacher's role could be changed to more guidance based."

"I think for science subjects such as physics, chemistry and biology, virtual reality technology can help a lot in the process of teaching and learning and provide a micro and a macro view of the subject. Also, it can create a learning environment for language learning and teaching. I still remember that when I was in high school, the math teachers were enthusiastic on the learning of Sketchpad software because it can create the mathematical equations electronically instead of teachers writing on the blackboard. So, I think in this sense the technology has improved our learning and teaching and it makes the demonstration of the teaching and learning content more straightforward and easier to understand."

"It can provide students a really authentic environment to experience the knowledge and the students don't need to imagine the knowledge because the virtual reality already provides the imagination for students, they just need to receive the knowledge and immerse themselves in a virtual world. It is quite convenient and cost effective because students can just experience knowledge and don't need to go far away to experience the real thing because of virtual reality is quite close to the real experience. Also, the form of the technology could motivate students to learn and make the learning more interesting, compared to teachers talk only. Also, if parents are willing to invest the advanced technology for students learning then this can be a very potential factor for the popularity of virtual reality technology."

"We can learn the knowledge deeper, because we don't need to memorize the knowledge deliberately. It just goes to my brain and I can just remember the knowledge I want to learn. Like the data shown in the demo, I can still remember them, one is 45%, another is 3%. By the way, is it possible to design the teachers in the virtual reality environment? If it is yes, then I want to have the teacher with the appearance I like the voice I want to hear during my learning. Or me as a teacher, I could just have my own image appearing in the teaching environment, I think."

"After what I've experienced just now, I think the effectiveness of knowledge retain is better than traditional learning and for less creative people this kind of immersive 3D technology can provide learners the platform to think and to create. But still, which need to consider which subject is suitable to use and which subject is not."

"I think virtual reality technology is kind of advanced and trendy. Previously, we used textbook and multimedia to learn, maybe in the future, we depend on this kind of cutting-edge technology to help us to learn better and in a more efficient way. Virtual reality technology is quite suitable to explain complex ideas and models in the learning, such as the knowledge we cannot see apparently or notice easily. For example, in physics, virtual reality technology can well represent the inertance and weightlessness because in the virtual world you can easily just feel that, right?"

> "I see the virtual reality technology as a bridge to time and space. For example, when we are learning literature courses, the authors are no longer living in this world, but we could use virtual reality to bring students into the world that the author was living, also if the learners are in the particular area and they cannot travel, it will be a huge advantage for learners to communicate with other people in other parts of the world. And for the device owners if they have the integrated cameral on their headset and share what they can see with other people, the 360 degrees sharing, like the video chat, then it would be fantastic!"

Some participants thought the reasons for the popularity of virtual reality technology in the classroom was because it is easy to use:

> "The good thing of VR headset is you don't need to install them in a lab. They can just be stored in a box and move to wherever needed. Like using iPad in the classroom, students just get the iPad from a box, but they installed screen and case protection for all iPad in that box to protect the equipment. I think I'll use this kind of portable device since it provides better quality of the image and I can see through the lens clearly. And for my classroom teaching, in terms of English language teaching, students are not required to walk around the classroom to learn, so I think this portable device would be suitable for language learning in the classroom."

> "We have language lab for English teaching and learning at the moment, but these virtual reality devices, they are so portable, so we don't need to preserve a room or set up the room before using them. We can just carry them from one classroom to other ones, just with a big box, much easier."

Also, some participants mentioned manufacturing factors, such as the price of the equipment, sale techniques, and the marketing strategy:

> "First the price of the devices can't be too high, so schools are capable to purchase these devices. The technology can really help students to understand and comprehend the knowledge in the 3D world. If the virtual reality technology can be widely used in teaching and learning, I think at least its advantages outweigh the disadvantages. Also, the disadvantages should be reduced to the minimum. Marketing strategy should be another factor because if the virtual reality technology is advertised everywhere then people will know the technology and maybe we'll use that for daily life. If its marketing strategy is aiming to educational field then teachers, school administrators, and parents will see the potential of virtual reality technology in learning and teaching. Maybe the device providers should open more stores to let people experience the technology, then consumers will know the product exists. Also, sales technique is quite important as well, if the point of sale is for the educational purpose, then students and learners will be interested in this form of technology. And institutions will compete with each other, if one institution has used virtual reality technology, the others will follow the trend immediately, because they think they're lagging behind."

Interestingly, one participant mentioned that virtual reality could be used for future teacher training:

> "Actually, virtual reality technology can be used as a method of teacher training because in the virtual reality environment we could create a virtual learning or teaching environment for teachers to react and analyze the classroom management skills or their teaching skills. The process of this real teaching demonstration would be recorded, and teachers can save it for later use to reflect on their teaching."

Some participants considered that the popularity of virtual reality technology requires multilateral collaboration in schools or intuitions:

> "The first and the foremost will be the school administrators' decision and the weather the school has approved funding for the purchase of the devices. They may need to investigate whether the virtual reality technology has a positive effect on students' learning and whether the virtual reality devices will satisfy their teaching and learning needs. Then parents may have some influence on the use of virtual reality technology in the class as well, because parents think virtual reality technology is just for gaming and they wouldn't agree

their kids to use that kind of device in the learning process and will be worried about the addiction that the virtual reality can bring to the students. Just like iPad, parents thought the iPad was just for entertainment before the widely use of iPad or tablets in the classroom. Parents may have different points of view of the usage of iPad in the class. I don't think students will reject the use of virtual reality technology because I think they will like this kind of technology! For teachers I think they may need to consider whether they could achieve their teaching aims with the help of virtual reality technology, because the form of the technology wouldn't just for motivating students in the learning, but it actually could bring more efficient learning outcomes."

"Teachers may be another factor because if the numbers of the teachers are using the virtual reality technology widely enough then it would be a potential popular tool for other teachers' consideration in the world. For dangerous experiments, like some chemistry experiments, teachers can demonstrate the chemical reaction in the virtual world so students wouldn't have any safety issues in the real world. This is quite different from just playing a video because in the video we will just watch the content but in the virtual reality we are participating, so there are huge differences."

Unexpectedly, the durability of the virtual reality equipment was mentioned by one participant:

"Also, it is not water and solid resistant. If the IP68 can be added to the feature of the VR headset, like some mobile phones, then the devices would be much durable for classroom use. Maybe it can add Ag+ to be germ and virus resistible in the surface of the devices, because it can reduce the work of sanitizing the surface of the devices after uses."

Only one participant expressed some doubts of the popularity of virtual reality in the classroom:

"I don't think in the current situation the virtual reality technology can be popular to be used in the classrooms because it is still expensive to use widely. And I think one aspect should be mentioned here because students are not allowed to use or bring mobile devices into the class at the moment, so if the games are excluded in the virtual reality environment, then maybe this kind of technology could be used in the classroom to eliminate the possibility of technology addiction in the class. And teachers making themselves less useful because of the introduction and popularity of the virtual reality technology into the teaching and learning environment. Anyway, I think if we could use the virtual ready technology in the future then students may be more motivated into their learning and they may pick up some subjects that they were not interested again to get back into the learning process."

[Dimension 5: Teaching and Learning Content Outlook in Virtual Reality]

Most of the participants suggested that we need to promote communicative language teaching and learning environment and create a positive language learning environment in the virtual reality:

"I was thinking about we are now promoting communicative language teaching, so I think virtual reality technology could promote that and to make students to learn in the real language settings. And with the help of the technology, we can simulate the language learning environment in a more real way. It is better than teacher's talk and the use of pictures to demonstrate the knowledge and to stimulate language learners because virtual reality technology can help students to create and increase their creativity in language learning. Actually, there are lots of learning contents that have been developed for mobile devices so I think if we could transfer that content to virtual reality platform and make it more real and more immersive so the content building for language teaching will be more sufficient. Also, during the process of learning, I think if there is a help machine whenever I need. For example, during the learning process, I don't know a specific word, then I could just talk to the machine or just click the word then I could get the answer or the meaning of the word. I think the virtual reality technology could be mainly used in the language input classes, like intensive reading. And teachers can introduce the author of the text with the virtual reality technology. It

could be used to bring the learners to that specific time period and meet the author face to face so students could understand the background information of the writing and the experience of the author during that time. And this technology could be the replacement of any other technologies that have been used in the classroom."

"It would be better to have a target language learning environment for language learners to experience and immersed themselves into the language learning process, such as the native expressions from English speakers. After we have immersed a certain amount of time and content then we will automatically learn the language as addition to the text learning. As for linguistics, it is quite abstract and hopefully we can connect the knowledge with the graphical design to produce the easy learning materials for learners. For English literatures, some students may don't have the time to read all the literatures and they may need the introduction and more immersive experience to get to know the authors, the texts, and the background information of the writings. And this can be more vivid to demonstrate literatures than the text itself. In English writing, the virtual reality technology could represent the process of academic writing, such as the outline of the structure, thesis proposal, and the supporting evidence to guide the learners in their writing process. Also, during the writing process, I hope the machine could provide feedback on the language and structure on the writing. So basically, if you're writing on the left side of the screen and then on the right side of the screen there is a writing assistant, and it can tell you how to write and what kind of writing difficulties you're in encountering, so the assistant will provide instant feedback and explanation on your piece of writing as well. But here's another question, I don't think virtual reality devices will be friendly to sentences input like you are typing in a laptop or a computer with a keyboard."

"Actually, I think the setting of the learning material could be more vivid for students. For example, we could set up this kind of like new words learning scenario, so there are alphabets abcd to z and these letters can make friends with each other so they can form different words. In this sense, virtual reality technology could promote students learning motivation and make the learning process much more interesting. And it can also simplify the vocabulary learning process for students. Or we can use games to promote students' vocabulary learning. For example, we could set up some puzzle games and then ask students to use the letters to form different words in the virtual world so monsters will be vanished to protect our virtual world if students can combine the letters to the correct words in a given time. In this sense, students can be the leader in the immersive virtual world and motivate their vocabulary learning by defending the monsters to intrude their virtual world."

"For English language learning, I think first in the virtual world we can create a learning environment and learning context for students to learn. For example, in primary school English teaching, when we are explaining the term breakfast, lunch, and dinner, actually we could use the virtual reality technology to demonstrate how we could order the meals in a restaurant and students may have a straightforward feeling on the experience of the food ordering process. In primary school textbook, there are some pictures under the words and expressions so I think we could make and create a cartoon based on that picture and put it into the virtual reality technology so students would get more interested in learning multiple senses. So, compared to the video clips, virtual reality technology could make the video more vivid and more immersive which can bring students a more exclusive learning environment."

Some participants expressed the view that virtual reality technology can be just an adjunct to teaching and learning but with limited functionality in relation to the learning content in English language:

"I think for language learning the learning resources would be quite crucial to the learning process because the learning environment and the materials in the learning would direct students on their learning process. I know there are some prompts for language learners to learn a new language, but I think it would be better to have various functions to guide the learners under learning, such as using different attitudes, tones and expressions to communicate with learners. What I'm saying is when using the virtual reality technology, I want

to communicate with a more intelligent machine instead of a preprogrammed machine, which would make the communication more real."

"For English language teaching and learning, the virtual reality technology can be used to introduce the background knowledge, so when we are talking about the Charles Dickens, we could use the virtual reality technology to introduce the background information of the writing, such as Oliver Twist. But I think for grammar and lexical teaching you'll be hard to integrate the virtual reality technology because I have no idea how we can do that."

"I actually I couldn't answer that at that moment, but I think if we can learn something about culture before we study abroad will be much beneficial for our living. For example, we can use a virtual reality to learn how to order in the restaurant like in a French restaurant and it can create a mutual cultural understanding of cuisine as well."

Some participants recommended that other advanced technologies could be integrated in virtual reality to enhance teaching and learning experience:

"I think for English literature the virtual reality technology can integrate artificial intelligence so students could talk to the author of the literature and get to know about the author and students could ask the author questions if they have any. For English pronunciation course, the technology is pretty the same but if virtual reality technology could create the learning environment for learners to immerse themselves in the virtual world and be able to communicate to the machine, as the native speaker, and talk to the machine just like they're communicating with each other. Also, for interpretation, the virtual reality technology could set up a conference environment and learners could use that kind of environment to practice their interpretation skills."

"I can imagine that it would provide the learning environment for specific learning context. From what I learned by your description, I can only speak the words or sentences appeared in the screen but not produce my own sentences. It's just the limited function of speech recognition but I'm wondering maybe it could integrate artificial intelligence into this application so we could talk to a robot in a more natural way, like talking to Siri or Cortana. It would be better to have API to connect to Siri or maybe Alexa. I think for the future learning, in terms of the practical or real-life English, we could use this technology to have specific settings in London underground: assuming I'm lost, and I need ask the directions in an underground station. In this situation, it provides authentic learning context and learning materials to show me the way to ask directions. Or I could have virtual tours in London City, and I could use the VR device to talk to the local people and use Google Maps to direct me to my destination."

[Dimension 6: Teaching Practice Expectation in Virtual Reality]

Most of the participants expressed their expectation to provide an authentic teaching and learning environment for teachers and students:

"Like English grammar learning, it would be more interesting if we use the virtual reality technology to present the learning content. Maybe the teacher can present the grammar lectures in the virtual reality environment. This is just changing the way of student learning by adding a headset and pre-recorded lectures, but the content of teaching would remain the same as the lectures in real life. After the lectures, quizzes would pop up to test students' learning outcomes. Another promising way of complementing the teaching practice would be the English for life purpose. Teachers can use the VR technology to demonstrate the English skills required for real life. For example, students are learning how to take a train from London Kings Cross. The 3D view of London Kings X Station would be pre-recorded, and students can experience buying train tickets from ticket machines, buying snacks from the shop, listening to the broadcasts of the departure trains, then passing Automatic Ticket Gate, finding the reserved seats, having on-board staff ticket checking, and so on. Just

immerse students themselves into the virtual reality just to learn the basic life skills and language skills when traveling or studying abroad. Or when teaching English poetries, teachers can use VR technology to introduce the life of the poet and how did the poet manage to produce the poetries. Students will experience the scenario of the poetry creation. Also, with the use of the technology, students can learn extensive knowledge that would never be taught in the traditional classroom. Also, it would be much easier for the virtual reality technology to present the details of a chemical structure, such as the molecule composition."

"I hope we can create a learning environment that could improve students' language ability and develop their language skills for real use not just for the language tests. For example, we could create an authentic learning environment that a learner could join the conversations in a group of people, so the learner could be more motivated to learn the language in the real world and for real purpose. For teachers they can guide students to solve the problems in the communication process and encourage them to express themselves in the virtual world, so students could probably transfer this commutative competence in the real world. The robot or classmates could guide or help the learners in the virtual world as well."

"Virtual reality technology can integrate the textbook from the curriculum then it could assist teachers to using the materials in the textbook. And we could integrate the existing picture book to the learning environments as well but turning the static pictures to anime or cartoon for students as additional learning materials. Also, our learning materials can be theme-based, and it can integrate games with rewarding mechanism. Students can have their own learning materials and their own learning progress during the learning process. For example, teachers can assign students several core learning materials and several selective learning materials in the virtual learning environment, students with fast speed could finish more selective learning materials while students with lower speed could just finish the core learning materials only. Maybe it can detect how concentrated students are while they are learning so the machine could remind students to re-concentrate to the learning materials if they are distracted or absent-minded."

Some participants expected that virtual reality could be interactive during the teaching and learning process:

"I would expect that when using the virtual reality technology, the learning process can be interactive, and it can provide feedback for students learning. If the technology can simulate a real learning environment for language learners and help students to learn, such as the preparation and review of the learning materials. Also, a virtual reality technology could promote students speaking ability because you can create a real learning environment for language learners. Also, I would expect that it can provide teachers an overview of students learning process so teachers could arrange the teaching accordingly. We could have a specific class to use a virtual reality technology that combines various materials in different courses, just like a language training class. Actually, I'm thinking that if the teacher can join the students in the virtual world, then the effectiveness of learning may increase somehow."

"I think for my teaching practice I would like to know how to combine or to connect the abstract knowledge with the graphical design in the virtual reality, because as a teacher if I don't know the graphic design, I may not have the capability of presenting my teaching materials in the virtual reality. Because in linguistics when I was analyzing the structure of the sentences, it was quite difficult to understand at that moment and I need to revise that abstract knowledge so I would hope that this technology can create immediate understanding of the abstract knowledge, or the concepts, so it would save both teachers' and students' time, and more motivating for students and attractive for learning experience. Students may feel more at ease to interact with each other in the virtual reality world and less fearful and intimidated when learning difficult concepts or knowledge. Because after students have used the device to absorb that difficult knowledge, teachers would help students to digest the knowledge, so in this sense, it increases the interaction between students and teachers. Virtual reality technology could just be used as part of the classroom instruction because if students have any questions during their learning in the virtual world, they could ask the teacher to answer questions so teachers could guide their learning when students are on or off with the devices. Also, students need to take a break in between because of the weight of the device. It cannot replace the role of the teacher currently, but teachers can co-exist and communicate with each other in the virtual reality world, but they

don’t have straight eye contact and immediate reaction to the body language and facial expression. If there is a chance to have eye tracing and body language representation in the virtual world, that would be terrific!”

“Actually, I am thinking about how virtual reality can improve students’ vocabulary learning. Maybe we can integrate games or other memorable parts for students to learn new vocabularies and they can understand what they're learning. Learning new vocabulary can be like gold mining. So, in the virtual world a student is mining the gold but actually they’re mining vocabularies. Because for VR games, they are quite immersive, so if we add the learning elements into the VR games, students would be more motivated and interested in playing the game and learning the knowledge. And their learning efficiency would increase during the use of virtual reality technology since they can learn in different ways such as different versions of textbooks could be integrated in the technology so that students can learn by themselves outside the classroom. Also, it can create a chance for students to cultivate the ability of learning independence and they can process the learning materials and digest the knowledge on their own speed and review the knowledge at their own pace. In the class, teachers can summarize the common mistakes that students would make in their learning process and based on their learning data, teacher can tailor the exercise for each student. VR technology could access students learning process and provide the feedback for later study. Also, when students are using the technology after class, they can share the experience of using virtual reality in their learning process to the whole class so that the class would have an understanding of their peers’ process. At the same time, based on the feedback of students learning teacher would make improvement for the virtual reality learning environment and learning materials.”

Some participants proposed that other advanced technologies could be integrated into virtual reality to complement their teaching practice:

“We can integrate virtual reality and other methods of artificial intelligence. Frequent English listening and speaking through virtual reality can help improve English skills. You can watch movies together virtually and teachers and students can share a workshop to simulate a conversation, inspire thinking and exchange ideas.”

“And I think for the background information learning, if we can create a real learning environment for students to understand the background of the writers, like Charles Dickens, students could directly speak to Charles Dickens in the virtual reality world and ask him specific questions. For this I think it needs to integrate the artificial intelligence into the virtual reality technology because the AI could simulate the sound and the speaking style of writer in that specific background.”

Participants also commented on the limited functions of classroom management in the virtual reality environment:

“As I said before, when we are using virtual reality headset in the classroom teaching, I was thinking if lots of students are using the headset at the same time maybe the speech recognition would be interfered by the noises, so I would expect the function of noise cancellation could be added to the headset. You can use a social function in the virtual world so the students in this classroom can communicate to the students in other classrooms or in other parts of the world. So, for classroom management I would expect that it should be much easier for teachers because if we are using a virtual reality headset, we're not only managing the students but also managing the devices as well, and teachers need to track students’ learning progress so it will be a much more difficult to control all these factors in the class. Maybe a classroom management software integrated in the headset for teachers would be a better choice. Also, when students are not in the school after class if they want to review the material, we need to find a way to share the learning materials to the students across the platforms not only in just in the virtual reality world, but it can also be transferred to other platforms. When the price is acceptable for students, then students can have their own devices so they can have the devices at home, and it would be much easier for students to review some materials learned in the class. So, I would say the replicability would be the key issue here. Also, I wouldn't think teachers would use virtual reality technology in every single classroom. It will be just used when we need to.”

"The teacher needs to have the control of students' virtual reality headsets. I think teachers are able to pause all the learning materials and students learning progress when students are wearing the headsets because the teacher may need to illustrate or demonstrate the knowledge in detail to help students learning process even if they're learning with virtual reality technology. Also, the operation of the virtual reality environment cannot be too complex for teachers to use and teachers are easy to learn how to use the device as well. I hope this technology could provide the solutions to students with achromatopsia or learning disabilities."

"Also, in the learning environment teacher can see and control what students are experiencing in the virtual world. Noise canceling technology should also be available in the virtual world because students made talk a lot and may interfere with each other during the learning process. And for students with different language abilities, I think the learning content could be adaptive so students can be presented with different learning materials that suit for their language level so things would forget there in a language learning classroom, instead, they are in a virtual world. If students cannot express themselves, they can use body language or gesture to let the machine know that they are not capable of expressing the learning content given."

Some participants urged that we may need extra backup to support virtual reality devices which would need to be in a more compact size:

"First, I would expect the virtual reality devices will be more compact and smaller for us to use, because for students in primary school they may feel too heavy to wear the headset at the moment."

"I think we could have two sets of virtual reality equipment at the same time. For example, if we have 40 students in a class then we may need to prepare 80 headsets so students could use the devices alternatively."

"But this has disadvantage as well, like students would be tired after using the device after 20 minutes because they may feel the device, or the headset is quite heavy to wear so they may need some time to relax and maybe have a break to continue to use the device for their language training."

Some students proposed that virtual reality technology can promote other forms of learning, such as distance learning:

"Maybe we could use this technology to promote distance learning, like online classrooms. It can broaden the way of reaching valuable knowledge. If we could widen the participation by sharing the learning and teaching materials, that would be beneficial to the society, not just thinking doing business and making money only. We should trial the technology in small scales and to see the actual effect on teaching and learning. If you see this is the future of the teaching and learning, you should make every effort to make it happen and to check how it goes through, having a big picture and not just limited to one area. We could choose our own teaching material in the VR environment, not just limited to the textbooks required in the curriculum."

"Virtual reality is a great tool for distance learning and simulate the classroom. If I were a teacher, I would feel very happy to have virtual reality. It would be great to have a virtual reality device like this. We can use virtual reality to teach in a different way. With virtual reality we can see the scene in the distance and there will be real feelings, very real feelings. Virtual reality can provide a more realistic feeling than words."

Some participants suggested additional functions should be added to virtual reality environment and addressed other issues as well:

"I think the teacher can coexist with the virtual reality technology but other technology tools. Because for now when students are wearing the virtual reality headsets, they cannot see teachers and it's hard for teachers to control from monitor students learning progress thought teachers still need to guide students on the use of the virtual reality headsets. If the role of teachers is challenged by the virtual reality technology, then teachers wouldn't use that to threaten their job security. Also, if we could write in the virtual world, just like we could use a pen to write on the touch screen, then it would be extremely convenient for teachers and learners.

Maybe the devices could be light weight? Because this is quite heavy for me. I hope students can communicate with each other when necessary and the system can track and monitor whether students are focused on learning or not and push alert notifications if they are not. If teachers can share the screens from teacher's headset, then students don't need to operate the virtual reality headset on their own because what students need to do is just to wear the headsets properly so no being much easier for teachers to monitor students' learning. Also, we could invite other guests from different places to join the class and the learning content could be adjusted by students' learning preferences or learning styles."

"Actually, I am expecting that the mixed reality can be used in the classroom because it can have both functions of virtual reality and augmented reality so we can use the devices in a multifunctional way. Students can have self-autonomous learning whenever or wherever they're wearing the headset if their safety is ensured."

"Students can be given exercises using virtual reality. It would be nice if a virtual teaching system could mark homework automatically. Virtual reality should be able to grade students' work and encourage correction. Virtual reality can parse students' work without having to be evaluated by a teacher. Through virtual reality, students can seek solutions to difficult problems. Virtual reality works like a real teacher to help students solve learning problems. Through virtual reality, students can understand where the problems are, what went wrong, and how to solve them. Virtual reality has intelligent automation function. The classroom teaching can use the game teaching through the virtual reality that deepens the knowledge study and the consolidation. Using virtual reality to create 3D video of teaching content to conduct classroom teaching. Teaching through virtual reality is more situational. For example, the learning of English literature can be assisted by animation produced by virtual reality. We can also display the plots of literary works through virtual reality."

"Also, it's better to have a larger capacity for battery or fast charging function to satisfy the longer use of the device and reduce the time for charging. The learning content should be classified to various grades or levels and no advertisement should be allowed to pop up during the learning process."

Interestingly, one participant expressed the intention of implementing the virtual reality technology into students' entire learning journey in the classroom:

"First, I think if I'm using virtual reality technology in my classroom I would make my teaching a little bit longer rather than just 45 minutes because in this 40 or 45 minutes you couldn't learn much in this kind of environment, so I suggest that if we are learning a language maybe we could have double time for learning and teaching but we could have short breaks in between so we can arrange more time in immersive learning in the virtual world. I suggest that because some students may need some time to get used to the headset and the virtual world since they need to transfer themselves from a real world to a virtue environment and they may need more time to explore in the virtual world and learn the language in the virtual environment. That may take some time before they enter their real learning process. If large portion of students couldn't get used to the device for the virtual learning world, then we need to change to other technologies or methods to teach the language.

[Dimension 7: Virtual Reality Implementation Obstruction]

Some participants were quite serious about how virtual reality might challenge the current role of teachers in the classroom:

"I think students would interfere with each other since everyone would wear a headset during the class if they need to talk to the device altogether. Using this form of technology would also influence and weaken teachers' role in the classroom because teachers are not dominant in the classroom anymore. Maybe it is more suitable for self-learning if it conflicts with teachers by using didactic method. I'm thinking what's the meaning of teacher after all the students are using the device for the whole classroom time. And why do we still need teachers if we can use the device for learning by ourselves in the classroom? I think it's fine to just

use the device for a short period of time, like 5 to 10 minutes, or the technology would dominate the class instead of the teacher. I think this is just a way to reinforce students' learning outcomes."

"Also, teachers' role could be challenged by the virtual reality technology because when students are wearing the headset, they may not be aware of teachers' talk and presence, and they may think the teacher is not that valuable as before so they would blame teachers more often."

"The virtual environment is somewhat detached from reality and will reduce the on-site communication between teachers and students. So, the use of virtual reality must be limited. I think the use of virtual reality should be handled well. Too much use of virtual reality may weaken teacher's status. Because of the multidimensional teaching of virtual reality, the teaching tasks for teachers are relatively simple. Teaching with virtual reality will be more authoritative and more scientific. If the virtual reality can replace teachers in the class, then students will think they can learn everything at home and have no need to go to school. So, the teacher will have a sense of loss because of that."

"Some teachers may not prefer the use of virtual reality technology in the classroom because they think their teaching status would be challenged and the virtual reality technology could replace them. Students may get addicted to the technology and it would be hard to pull students back to the real-world teaching and learning environment. Also, the exchange of feelings and human communication needs cannot be satisfied in the virtual reality teaching environment."

"If the virtual reality technology is widely used in the classroom, then the teacher's role could be challenged because students may have less interaction with the teachers in the class because they will have more time with the technology and the virtual world. The teacher will feel more difficult to control the class because of less interaction time with students. If some students are encountered with some technical difficulties in using the virtual reality devices, a teacher may don't have an immediate solution for students, then students would consider the useless function of the teacher in the class. In this sense, the teacher needs to spend lots of time in the class to manage the devices and the students with the devices as well."

"Also, some teachers may feel insecure because they think virtual reality can replace the role of teachers, because unlike other multimedia platforms, when students are wearing the virtual reality headset, they couldn't see the teacher at all. But at the same time, virtual reality technology can be just a method of teaching aid because we wouldn't use the virtual reality headset for too long because this is too heavy, but I don't know what will happen in the future. Also, teachers will worry about when students are used to the learning in the virtual reality, they would prefer learning in the headset instead of with teachers' guidance. Therefore, students may think their teachers' lessons and teachers talk would be less interested compared to the learning in the virtual world. Also, the availability of the equipment would be another factor since not all schools are able to purchase such trendy and expensive technology for teaching and learning. Teachers may lack of training or lack of knowledge to use the technology in the classroom."

Similarly, some participants worried about teachers' ability to develop or design teaching materials for virtual reality teaching and learning environments:

"Then teachers will even feel harder if they want to create their own teaching materials in virtual reality environment since it requires skills in application development. Because of lacking teaching resources, teachers would less likely use the devices in the classroom. Also, I experience some dizziness when the video is zooming into the details so I'm thinking how teachers can manage to reduce the motion sick in the virtual reality when they're creating teaching and learning materials?"

"The expectations for teachers. Teachers cannot design the software by themselves so if they need to improve their teaching materials to modify their teaching contents, they need to contact the special Technical Support to help them. Also, the bad design of the virtual reality software will have negative impact on students learning experience. For example, if the software in a virtual reality is not designed for comfortable use, then students may get dizzy a lot and they cannot continue to use the device anymore after a short period of time.

Also, because students are wearing the headset during the learning process so teachers could not detect whether the students have understood and knowledge or not and students cannot pause the learning content if they have any questions during the learning process. Also, teachers may feel too complicated to learn how to design 3D objects and rendering all these virtual reality contents and if they can, they may not have a powerful computer to do so. Because of lots of factors such as students cannot pause the learning material, the headset is too heavy, the learning content is difficult to build for teachers, and the difficulty of maintaining the device and so on, so these can prevent teachers to use the device for whole class. So, in this sense, virtual reality technology can just be used to assist teaching learning or part of our teaching process for a short period of time. Also, not all of the teaching process will need the use of virtual reality technology."

"I think it's impractical to use VR devices in teaching currently. If we are using the VR to assist the teaching, teachers need to develop their own teaching materials by using 3D modeling software and it requires quite amount of knowledge to do that. It also needs high-performance computer to do that, and it takes time to develop the material and render it as well. It's not as easy as using PowerPoint to develop their own teaching materials; it would just be unrealistic if we don't have large amount educational resources in the market or we have some elite technical team to help with that."

Some participants raised the issues of classroom management and possibilities of personalized learning in the virtual reality teaching and learning environment:

"Teachers may not be able to monitor students learning process because teachers cannot see what students are doing in their headsets. But teachers can promote students learning progress as they are learning in the virtual reality world, like a guidance."

"Students may have different personalities and different characteristics, so I'm not sure how virtual reality can tailor this kind of experience to each student and to satisfy their learning needs. Because in the traditional classroom teacher can be aware of students' reaction and provide feedback for any help if needed but in the virtual reality, I don't think it'll be possible for teachers to assess students' learning and provide feedback during their learning process. Also, it's hard for teachers to manage students learning progress and their learning outcome so teachers may not be aware of how students have learned and what is the learning effectiveness of each student because some students may just concentrate on the format of technology instead of the content in the virtual reality."

Some participants responded to the disadvantages of the technology itself, such as battery life and motion sickness:

"Also, you need to charge the devices from time to time. They need to get charged as soon as possible when finished using and need be ready for the next use. We need to leave enough time for charging before we can use the devices for another classroom."

"And some people may feel motion sickness while they're using virtual reality devices so if the technology can reduce the motion sickness, then it could be better to use in the classroom, so we can be less concerned about the health and safety dimension in the class."

"Some students may refuse to use the virtual reality technology in the class because they may think the headset is too heavy or uncomfortable for them to wear so teachers need to prepare other learning content for them. Teachers cannot track or monitor students learning progress or whether they are focused on the learning process as well. Also, students may need extra space to use the headset because when they are turning their heads around, they may bump into each other to generate safety issues compared to the traditional classroom seat arrangement."

Some participants stressed the importance of the storage and maintenance of virtual reality devices:

"Device storage is another problem; I think we need a special box or storage room to store this kind of device such as the devices can be charged together at the same time and the lens need special protection not being

scratched or damaged. But in terms of the working and storage conditions, it requires less compared to building a computer room for language learning. I think the major issue here would be teaching resources. If there are not sufficient teaching resources for teachers to choose, then it would be harder for teachers to integrate their current teaching plans into the teaching sessions with VR devices."

"I don't know how much to cost for the maintenance because as the virtual reality device is quite delicate and it may need additional maintenance to keep the device working so it would cost more money to use the technology in the classroom."

"Teachers need to share the responsibilities of device maintenance all the time and they need to prepare extra headsets in case that some devices are not working or damaged by students in the class. And this may influence students' learning progress and teachers' teaching schedule if the devices are not working functionally. But I think here may be one of the solutions for that. The devices can be remarked by numbers and students will be assigned to a specific device with the specific number so if the device is damaged then it'll be much easier to identify who has damaged the device and who is going to take the responsibility."

Participants raised the issues of the virtual reality implementation obstruction from multilateral influence coming from school administrators, teachers, parents, students, the technology itself and so on.

"I think not just only for teachers but for school administrators they would have similar problems with the implementation of virtual reality in the classroom. The first thing would be the financial issue. Schools may think the virtual reality technology devices would cost too much to build a complete virtual reality learning environment and they may think it is not necessary to use that kind of advanced device for students and teachers currently, because it is doubtful that whether virtual reality can increase students' level of grades of examination or not. If students and teachers have tried technology and they think virtual reality could increase their learning effectiveness, such as the students could learn the knowledge easier, or they may spend less time on the learning process. In this sense schools may consider purchasing more equipment for students to help their learning process. And currently we have no sufficient evidence to prove the virtual reality technology will not have negative impact on students' or teachers' eyesight. Parents may oppose to the use of virtual reality technology in the classroom because they may think if students are using that kind of gaming device during their learning the parents would think it is not worthwhile to go to the class in that kind of learning environment, or we say gaming environment. Also, the unfairness of the access to educational resources would be another factor for students even get to know the form of virtual reality technology."

"Also, parents will have various reasons to reject the use of VR technology in the classroom. They may not know what the VR is or may not understand why teachers would use such a fancy gaming device in the classroom but not support students learning in the reality, like the real reality. They may just prefer the teachers to stick to the traditional ways of teaching like they did in the past. We have financial bursary on these new tools but now every school or university would get that. If we don't have sufficient money invested, we may not fully understand the technology and not able to fulfill the full purpose and value in teaching and learning."

"Another important factor should be considered is the level of students, so if the students are too young to use the device the virtual reality technology may have negative effect on their learning because young students may focus on the form of the technology instead of the content that the technology could provide to the learning."

"And there is still need some analysis for teachers and school leaders to show them the effectiveness and cost effective of using the virtual reality technology in the class compared to other formats of multimedia that has already been used in the class. Why we need to buy the virtual reality devices and what kind of data can be provided to persuade school leaders to purchase the devices. And we still need proof that the virtual reality wouldn't distract students learning process too much and it can bring positive effects to students' concentration on learning."

"Not everybody would accept the innovative technology and people need time to get to know the technology to accept it or reject it. It would be hard to promote VR technology in the classroom. Currently this is just for entertainment. It would be impossible to use it in places where the basics in education still needed. Maybe small-scale use would be fine at the moment but not in a large scale. You have to make sure every person wearing the headset is not doing anything else but the instructions from teachers. For example, the teacher could share the screen from teacher's headset, then students could see the learning material from their headsets simultaneously. Or let students explore the learning material by themselves. The devices are owned by the university and it can only be used in the university. If the students need to use at home, they may need to spend extra money on the devices. And parents would think the main reason to buy the VR headset would be gaming instead of learning. And students may use the VR headsets for other purposes that may affect negatively to their learning performance. But here is the question, whose fault is this? The student or the technology?"

5.5.4 Research Question 3

Research Question 3: What are the pre-service teachers' perceived ICT and virtual reality training needs?
Data Source: 1) Pre-Service Teachers' Perceptions on Virtual Reality and ICT Training Needs Questionnaire Section 3 [Attitudes to ICT and ICT Training] [Reasons for ICT Training] [Expectations of ICT Training] [Preference of ICT Training] 2) Interview Questions 8 to 9

Table 26. Research Question 3 Overview

The third section of Pre-Service Teachers' Perceptions on Virtual Reality and ICT Training Needs Questionnaire and the interview questions 8 and 9 were analyzed to answer research question 3. The third section of Pre-Service Teachers' Perceptions on Virtual Reality and ICT Training Needs Questionnaire mainly investigated pre-service teachers' perceived ICT training needs, which also contained four components, and the interview questions 8 and 9 measured pre-service teachers perceived virtual reality technology training needs. The result of the descriptive statistics of each sub-question in four components in the questionnaire including Attitudes to ICT and ICT Training, Reasons for ICT Training, Expectations of ICT Training, and Preference of ICT Training was shown in Table 27. The standard errors were within a narrow range indicating that the spread of responses was similar for each question. The mean value of all items was in the range from neutral (n=3) to agree (n=4), and the mean value of two items were extremely close to "neutral", i.e., the item "1. I have the required ICT-related skills" (mean =3.02) and the item "2. I have the necessary ICT-related skills" (mean =3.04).

Items	Mean	
	Statistic	Std. Error
[Attitudes to ICT and ICT Training]		
1. I have the required ICT-related skills.	3.02	.060
2. I have the necessary ICT-related skills.	3.04	.058
3. I'm confident in using basic productivity tools.	3.35	.058
4. I'm confident in using educational software provided by the university.	3.50	.055
5. I'm interested in ICT using in classroom instruction.	3.63	.055
6. I often incorporate the use of ICT in classroom instruction.	3.12	.056
7. The contribution of educational software is significant in my professional development.	3.60	.056
8. I believe that ICT training can have a positive effect on my professional development.	3.78	.055
[Reasons for ICT Training]		
9. ICT training is a significant component of my professional development.	3.65	.053
10. I can take advantage of ICT to use it in course preparation and teaching issues.	3.69	.051

11. I can take advantage of ICT to use it for my own personal purposes.	3.71	.052
12. I will have the chance to communicate with and make acquaintance of other colleagues with ICT.	3.56	.056
13. A certificate in ICT training will contribute significantly to my salary prospects.	3.56	.054
14. I can have time off from the school environment when I attend training.	3.47	.054
15. ICT training is deemed mandatory by the authorities of my training institution and by the Ministry of Education.	3.45	.050
16. I will be reluctant to use ICT in the classroom after the ICT training because my students may know more than I do about using ICT.	3.20	.061
[Expectations of ICT Training]		
17. I would like to improve my ICT literacy through ICT training.	3.83	.053
18. I would like to participate in introductory courses in Internet use and general applications.	3.77	.052
19. I would like to participate in intermediate courses in using teaching tools for the classroom.	3.78	.052
20. I would like to participate in advanced courses in the application of teaching tools for the classroom.	3.78	.051
21. I would like to participate in courses on pedagogical issues related to integrating ICT into instruction and learning.	3.73	.051
22. I would like to develop closer relationships the colleagues through ICT training program.	3.82	.051
[Preference of ICT Training]		
23. I prefer a short time for ICT training (2-4 hours).	3.49	.057
24. I prefer a training program that lasts about a month.	3.45	.055
25. I prefer a training program that lasts no more than 3 months.	3.34	.057
26. I prefer a training program that continues over whole semester.	3.22	.062
27. I prefer ICT training provided by other institutions rather than from the Ministry of Education, Lifelong Learning etc.	3.30	.058
28. I'm willing to join the ICT exchange training programs abroad.	3.64	.058
29. I would prefer the government or the university to pay for my training.	3.81	.055
30. I would be happy to pay any training fees myself.	3.20	.064

Table 27. Descriptive Statistics of Pre-service Teachers' Perceived ICT Training Needs

The interview data has shown that pre-service teachers perceived virtual reality technology training needs are based on the following aspects: the basic operation of the devices, development of teaching and learning materials, solutions for contingencies, and other trainings.

The majority of the participants stressed the importance of the basic operation of virtual reality devices:

> "I think teachers need to know how to use the device, to get familiar with the software and settings, and to know how to teach students how to use the device."
>
> "I think training can be provided in such areas like the basic usage of the device, the installation of the software, the deployment of the learning environment. Also, teachers need to get familiar with the learning materials in the virtual reality and how to manage these learning materials in the virtual world. Maybe it would be helpful to have some basic understanding of how to use the virtual technology in their teaching."
>
> "At first and the most important thing will be the use of the interface, like every button in the interface, and how to use a controller to control the content in the headset. Teachers should be aware of and the consequences of pressing the button or the menu in case that some incidents happened during the teaching."
>
> "The basics would be how to use the technology and how to present the teaching materials to students by using this device. In other words, how can the teacher transfer the current and existing teaching materials to the virtual reality environment. And teachers need to know every button that can guide students to other functions because students may click the button randomly and problems may occur during that process, so as a teacher, I need to get prepared to solve all sorts of problems."

Most of the participants addressed the importance of the capability of teachers to develop teaching and learning materials for virtual reality environment:

"Teachers need to know how to design the learning materials and teaching materials. Technical Support may be needed to help teachers to design the learning and teaching materials."

"Then teachers need to know how to create teaching materials in the virtual reality world. It is quite easy to make a PowerPoint for teachers nowadays so I was thinking if the content creation for virtual reality technology is as easy as in making a PowerPoint, then teachers wouldn't worry too much about the creation of teaching and learning materials in the virtual reality. Teachers may share their learning content with each other so it will be much easier to create a virtual reality community for the teachers."

"I think for the virtual reality technology, one important thing would be 360 degrees, so teachers need to know how to record this kind of 360-degree video and integrate the teaching materials into the virtual reality learning environment. At some point, the virtual reality technology is kind of complex at the moment, so if we could reduce the complexity, then teachers may do not need extra training for classroom use. Also, teachers need to know what kind of classes or what kind of courses could integrate virtual reality technology and how to do that appropriately. Also, the teacher could share their teaching practice with other teachers, then this would be more sustainable for other teachers to learn to implement the technology in the classroom."

"Also, teachers need to monitor students' activities in that device, the classroom management. I wish to have the long-term training sessions and get trained periodically, like the newest information on virtual reality technology, the progress of the courseware development, the advice from the technical team. The communications between teachers and courseware developer are important, then teachers could provide the pedagogical feedback whereas courseware developer could provide technical support and improvement based on the feedback from teachers. But teachers should play a dominant role in courseware development; for example, they can modify the existing teaching materials by themselves easily. Developers should leave the spaces open for teachers to modify the teaching materials if they need to. Actually, we could change the term 'training' to 'meeting'. Teachers from multidiscipline subjects could join the meeting together. Teachers could learn from each other to see whether there are some take away points that could be implemented in their teaching. Or developers could composite the teaching instructions of the VR technology just like the user manual book."

"Maybe previous VR using examples in the classroom or the ways to integrate this form of technology into current lesson plan would be helpful as well. Also, the recorded lessons for other teachers to observe the effectiveness of the use of the devices would be great. If I need to develop my own teaching materials, how can I create them? How can I build an app for my subject? And how to integrate my own teaching materials into the virtual reality teaching environment?"

"Teachers could learn from the previous teaching practice with the successful integration of virtual reality technology, and they can ask for experts' opinion on the technology integration as well. It would be better that we can have a training for teachers to have pedagogical support on virtual reality integration, such as why and how we need particular software in virtuality to achieve our teaching goals. And I think some experienced teachers in virtual technology integration into their teaching, they can share the experience with other teachers who are going to use the technology or who intend to use the technology in their future teaching, such as how we could integrate the technology into our teaching learning, what kind of aspects that we need to pay special attention to, is it effective to use this technology in various aspects of teaching, also is this technology bringing side effects to our teaching and learning?"

Participants also emphasized that teachers need to be trained to deal with contingencies:

"Teachers need to know the basic potential problems that may occur in the class and they need to know the possible solutions to the problems. Teachers may need to test the virtual reality devices in a small group of students and ask for their feedback before the technology can be implemented in the class."

"We need to know what kind of contingencies we may incur during our teaching process because if we come across these issues, we could solve the problems as soon as possible so it wouldn't interfere with the teaching

process too much. Also, the teacher may need to know what kind of teaching resources available in the market and how to choose appropriate teaching content for students. Teachers need to know what kind of students are not suitable to use the virtual reality technology because they may suffer from the dizziness when they are wearing the headset. If the student suffers from discomfort, the teacher needs to know what the alternatives for students are to continue the learning process."

"If the students have encountered any problems during the use of virtual reality devices, the teacher may need to know how to solve that problem, I mean basic problems, so it can be fixed quickly in the class. And teachers need to know where to find appropriate teaching and learning materials for the virtual reality and if possible, they could create their own teaching materials."

Participants proposed that other training need to be provided, such as how to maximum of effectiveness of the usage of virtual reality technology:

"Other training like how we could use the technology and in which format, how we could access students learning progress and their learning effectiveness."

"Also, not only for teachers, but the administrative level of training should also be conducted as well because the administrators of the schools need to know how to manage these devices and how to assess the effectiveness of the virtual reality technology in teaching and learning. And this is quite similar to the computer training, we just have changed the type of technology."

"And I think training relating to student's learning is quite important as well because for this kind of new technology we don't know how well it can bring to our students and we don't know how this technology can help our students during the learning, so we may need to ask students how you want to use them and what kind of learning effect that virtual reality technology can bring to students. Besides, we may need to ask students first. After students have experienced the technology, I think it is our responsibility to ask students how they feel about the technology and what kind of improvements we as teachers can do for students' learning. Another point would be why we need to use the technology in our classroom and why we need to integrate virtual reality to our teaching, so we need to think about this before we implement the technology in the classroom to better use it during our teaching process."

5.6 Discussion

5.6.1 Research Outcome

This study investigated the pre-service English teachers' perception in relation to virtual reality in teaching and learning as well as their perceived ICT and VR training needs in China. Three research questions were answered in this study: 1) What is the status quo of ICT use and ICT adoption reported by pre-service English teachers? 2) What are the pre-service teachers' beliefs in relation to virtual reality technology for teaching and learning? and 3) What are the pre-service teachers' perceived ICT and virtual reality training needs? It was noted that the collection of background information of participants showed that the majority of the participants have access to mobile phone, most of the participants have access to laptop, more than a half of the participants have access to desktop computer, and more than a third of the respondents can access to tablet or iPad. However, only 24 participants have access to virtual reality headsets. Nearly eighty percent of the respondents had never attended ICT training courses in the past and only 60% of the participants had experienced virtual reality before. For the first research question, it was found that the technology tools such as PowerPoint, computers, projectors were mostly used in the classroom instruction for the replacement of the use of traditional blackboard and chalk. Also, it was stressed that ICT tools

used in the classroom have served the purpose of instruction and the tools make teaching more effective in the result of the classroom observations.

It was found that pre-service teachers have moderately positive attitude towards ICT and virtual reality technology in terms of openness to new ICT tools, perceived usefulness, perceived ease of use, and technological complexity. Participants also expressed their neutral attitudes towards the difficulty of learning how to use virtual reality equipment in language teaching and the difficulty to integrate virtual reality equipment in teaching to align with the teaching objectives. In the interview, more than a half of the participants stated that they had experienced virtual reality before, either in a research or in a shopping mall, and for those who have never experienced virtual reality before, participants hold a positive attitude towards the experience of the technology even though they experienced temporary motion sick. Most of the participants preferred standalone equipment for classroom use and personal use because the all-in-one device can offer optimized experience for virtual reality, but a few participants preferred gear VR for classroom use and personal use, and no participant would choose desktop-based virtual reality equipment for classroom use. The most mentioned expectations of teaching and learning environment for virtual reality was authentic teaching and learning material integration. Some participants had doubts, concerns, or denials of virtual reality for teaching and learning environment. Most of the participants mentioned the effectiveness of virtual reality in teaching and learning to gain its popularity, and others mentioned the ease of use, manufacturer factors, multilateral collaboration in schools or institutions, and the durability of the equipment as the main reasons for the popularity of virtual reality technology in the educational field. Additionally, the result suggests that the main factors that affect pre-service teachers' adoption of ICT tools can be categorized to intrinsic and extrinsic factors, and the extrinsic factors potentially have major influence on their ICT adoption.

In terms of teaching and learning content, most of the participants suggested that we need to promote communicative language teaching and learning environments and create a positive language learning environment in virtual reality, and other participants mentioned the limited function in relation to the learning content in English language. They recommended that other advanced technologies could be integrated in virtual reality to enhance teaching and learning experience, such as artificial intelligence. As for the expectations of teaching practice with virtual reality technology, most of the participants expressed their expectation to provide authentic teaching and learning environment for teachers and students; also, some participants expected that virtual reality can be interactive during the teaching and learning process and other advanced technologies and functions could be integrated into virtual reality to complement their teaching practice. The challenges of virtual reality technology implementation in the classrooms included the threat to teacher's role in the class, high level of requirements for teachers to develop or design teaching materials, the issues of classroom management and possibilities of personalized learning, the extra responsibilities of storage and maintenance of virtual reality devices, the multilateral influence coming from school administrators, teachers, parents, students, and the technology itself, as well as the disadvantages of the technology itself, such as battery life and motion sickness.

The third research question has addressed pre-service teachers perceived ICT and virtual reality training needs. The result of the questionnaire showed that pre-service teachers believed themselves to have moderate attitude

towards ICT training, but the result also indicated that pre-service teachers hold neutral opinions on the possession of required ICT-related skills and necessary ICT-related skills. The interview data has shown that pre-service teachers perceived virtual reality technology training needs are based on the importance of the basic operation of virtual reality devices, the importance of the capability of teachers to develop teaching and learning materials for virtual reality environment, the solutions to deal with contingencies, and other trainings such as how to maximum the effectiveness of the usage of virtual reality technology. Overall, in this research, pre-service teachers have moderately positive attitude towards ICT and virtual reality, and they have clear goals on their training needs to guide their implementation of virtual reality technology in classroom teaching and learning. This suggests that future initial teacher training specialized in educational technology could be integrated with the cooperation or collaboration with teachers specialized in certain English related subject area, such as literatures or linguistics. These experienced teachers would bring the depth of knowledge and rich teaching experience plus the technology specialist's assistance to redesign and improve the teaching and learning environment and experience, under the supervision of the quality of the teaching and learning experience so as to achieve the students' learning outcomes.

5.6.2 Challenges and Limitations

There are several challenges worth mentioning here. First, the design of the empirical research was not based on the result of the systematic review because the empirical study was conducted before the completion of systematic review. It was difficult to collect the data required with additional variables identified in the later stage of this doctoral study to perfectly fulfill the continuation of the systematic review. Also, before the data collection process, it was frustrating to get rejected or ignored when contacting potential universities or classroom teachers, and the number of responses didn't reach the level hoped for even when the researcher went to the classroom and made a personal introduction to the research project to potential participants. In addition, during the data collection, it was hard to assess the saturation of the data to satisfy the research questions, especially in the process of interview; it was difficult to decide whether more participants were needed for further investigation at the later stages of the data collection. Moreover, contingencies occurred during the data collection process. For example, during the interview, the app Mondly in Oculus Go failed to connect to the Internet for speech recognition. Furthermore, the numbers male participants in the sample were limited because of the significant gender imbalance in English pre-service teachers and it was quite difficult to include more male pre-service teachers to enrich the range of the data based on gender; of 299 participants, only 23 were male pre-service teachers. Last but not the least, because the questionnaire was slightly modified after the pilot study, the data from pilot study needed to be merged manually with other data in SPSS; it also took several months to transcribe and translate semi-structured interviews by researcher himself that were conducted in Chinese.

Notwithstanding these challenges, the empirical study has met the goal of answering research questions addressed and filled the research gap to contribute theoretical and practical aspects in the educational field in relation to pre-service teachers' perceptions about virtual reality technology and their perceived training needs, a number of limitations need to be acknowledged as a result of being a sole doctoral researcher with limited time and resources. As this research has adopted both interpretivist and pragmatist perspectives, it does not seek generalization because

of the small sample size. However, the insights from this study could possibly be extended to the wider context of pre-service teachers in major cities of China due to the similarities of the effort on the educational policies embodiment and the support for educational technology development in teacher education. Also, advanced statistical analysis, such as using regression models, was not adopted in the data analysis on account of the proposed research questions and limited variables collected in the data collection process. In addition, this research mainly investigated pre-service teachers' perceptions of virtual reality technology; the research would be more valuable if other stakeholders could be involved in the study such as the head teachers or school administrators to provide more insights into the use of technology and training needs of virtual reality technology. Furthermore, the imbalance in relation to gender in English pre-service teachers and limited numbers of universities included in the study would be another limitation of the study.

5.6.3 Implications

As mentioned earlier in the research rationale, the empirical research was based on and followed the current trend of educational policies in China. Pre-service teachers in China need to adapt to the recent and newest policies for their own development and for the advancement of society. China Education Modernization 2035, for instance, has put forward new proposals that China need to accelerate educational reform in the information age, build intelligent campuses, construct the platform of integrated and intelligent teaching and service, use modern technology to speed up the reform of personnel training mode, realize the organic combination of large-scale education and personalized cultivation and innovate education services, establish the co-construction and sharing mechanism of digital education resources, and etc. Consequently, it encourages pre-service teachers to assist the process of strengthening the construction of the system of curriculum and teaching material, scientifically planning curriculum, and making full use of modern information technology, in order to enrich and innovate curriculum forms, to improve the cultivation process of first-class talents and their innovation capability, to establish a modern education system of lifelong learning, and to build a world-class education sector with Chinese characteristics. In addition, the priority of the Ministry of Education in 2021 is to actively promote the construction of educational informatization, and the main tasks are to enhance the development of the high quality of educational informatization, actively develop Internet plus education, and ensure the safety of the network of the education system. The issue of the Medium-To-Long-Term Development Program of Educational Informatization (2021-2035) and the 14th Five-Year Plan of Educational Informatization provide the guidance of the promotion of Internet plus education and the exploration of the pilot projects and models of educational informatization. Therefore, using these policies as a guidance for developing a smart plan and a wise pathway for pre-service teachers' cultivation and education in China would be the most sustainable and efficient way to cling to the country's strategy of development and prosperity.

Although this empirical study has investigated pre-service teachers' perception about virtual reality technology and their perceived training needs, the importance of augmented or mixed reality, or even extended reality should not be ignored with the advancement of the technology because it provides the opportunity to combine the strengths and thrill of virtual reality. The newly developed Windows Mixed Reality and Microsoft Mesh merely require the mainstream hardware configuration, and a variety of headsets are available in the market currently at a reasonable

price. Furthermore, the fast pace of artificial intelligence will enable more immersive environment for teaching and learning with speech recognition, user computing and interacting communication preference. However, challenges of the virtual reality implementation in education may include the high cost of the devices, the discomfort of wearing, software development, teachers' and students' bias, and other challenges identified by this study's informants. These challenges in the educational field may need to be acknowledged from different stakeholders' perspectives so these challenges could generate opportunities in the future. Future research could be based on the relationship between pre-service teachers' ICT beliefs and the practices of integration of this technology in the classroom, as well as the changes on pre-service teachers' perception on ICT and cutting-edge educational technologies before and after Covid-19 pandemic with teaching practice. Though there are challenges ahead for the application and implementation of virtual reality in the educational field, I will use the quotation from Jou and Wang (2013) to end this chapter: "Virtual reality enables a learning environment in cyberspace that is more versatile than the traditional 'chalk-and-blackboard' classrooms in that learning takes place as individuals make exchanges of technological interactions either with other individuals or with whatever systems or software used; the application of virtual reality in education is a great leap of teaching methods after the multimedia, computers, and the Internet."

6. Reflection for Action

6.1 Reflection on Learning

My research journey started when I was admitted to EdD program at Durham University. There are two main reasons I chose the EdD program instead of the PhD program in the first place. First, this program contains two phases, taught phase, and research phase. In the taught phase, I could learn wide range of content knowledge and pedagogical knowledge from core modules and elective modules that could expand my horizon on teaching and learning in higher education, and in the research phase, I could conduct my own research and have cutting-edge results in my research field. The second reason is that this doctoral program is full time and mainly research based like a PhD program but there is an emphasis on the practice of teaching as well, and I intended to gain more teaching experience in higher education during my EdD study.

I have prepared for years to get myself ready for higher education teaching. In the first year of my doctoral study, I completed six modules and during my taught phase, I had a general idea of the educational system in the UK and the responsibilities of different roles in our department. I paid special attention to the teachers in the module and observed their teaching. I have learned that the teaching style is important, but the understanding of the subject and the discipline knowledge are even more important. Therefore, after my first-year taught phase, I started to work on my subject knowledge in my discipline, i.e., my research, aiming to get a better understanding of my discipline and my research field. In this spirit, I hope I could develop a balanced and evidence-based scholarship of teaching (Shulman, 2001).

As an enthusiastic learner, in addition to the completion of required six taught modules in the first year, I have completed more than 40 MOOCs mainly focused on teaching and learning and attended over 200 training courses at Durham University including but not limited to academic development, digital skills development, research development, academic English skills, and human resources. I have gained an adequate knowledge of statistics and mathematics for educational research. Besides, I have participated in various leadership and entrepreneurship training programs in preparation for my future career, which enables me to operate effectively in a rapidly changing and uncertain environment by developing new knowledge and skills as required. As an active researcher, I have helped in organizing two postgraduate conferences at Durham University, and participated in conferences at the University of Cambridge, the University of Warwick, and Durham University. Throughout these conferences, I have published two conference papers in proceedings related to the internationalization of higher education. Thus, I have developed a sound knowledge of core educational research concepts, research design and processes, as well as a repertoire of key research skills which support research projects in higher education.

In addition to relevant active learning and research experience, I have rich experience in the multicultural environment of teaching both in School of Education and Business School at Durham University by leading postgraduate and undergraduate workshops. I have marked formative assignments in an undergraduate module and provided useful feedback to students on thesis proposal development. Apart from that, I taught Chinese for three years in Durham Chinese School. Also, I was honored to be involved in producing the MOOC English Pedagogy, and

the complementary textbook in partnership with a higher education institution in China. Moreover, I have demonstrable practitioner experience and skills by achieving the Higher Education Academy Associate Fellowship status in recognition of attainment against the UK Professional Standards Framework for teaching and learning support in higher education. Therefore, I intend to develop and deliver high-quality teaching that contributes to providing a high-quality learning environment and curricula which enables students to achieve their value and potential.

Additionally, I have attended four major events regarding educational technology in my doctoral study. This enables me to have a deeper insight into the current and trending educational technology available in the market and the potential value of the application in educational filed. For instance, as a member of teaching team on the MOOC English Pedagogy development and my doctoral research on virtual reality, I can provide specialist advice and support to academics on the development and implementation of engaging and inclusive online learning technologies, as well as the strategies of using technology such as virtual reality in teacher training and teacher education. As a personal trainer, I could help staff boost their physical wellbeing in the college by offering fitness training sessions during the academic terms. I also have excellent communication skills with experience of working as part of a team and the ability to develop excellent working relationships both internally and externally. Likewise, I could provide services, events, and activities in the organization, as well as positively contribute to fostering a collegial environment and the commitment to equality, diversity, and inclusion.

In summary, I have developed my experience in teaching related to teacher training, educational research methods, English language, as well as insights into the use of technology in higher education. Furthermore, I am enthusiastic about engagement in scholarly activities to support high quality academic research practice and positive impact on the development of professional practice within the community and beyond. The transferrable skills I have obtained throughout my EdD study have well prepared my readiness for my future career, whether it is an academic position or a non-academic post. I have also developed resilience and the awareness of wellbeing during my doctorate study, especially during the difficult times in the pandemic. The advantage of the EdD program, the insight of my supervisors, and the nature of my curiosity have enriched my doctorate research journey.

6.2 Reflection on Teaching

6.2.1 Classroom Teaching: Educational Research Methods

My experience of teaching at Durham University was being a teaching assistant at School of Education in a postgraduate taught module: Design and Methods in Educational Research, a teaching assistant at School of Education in an undergraduate module: Educational Research Methods, and a teaching assistant at Business School in an undergraduate module: Research Methods and Statistics. In this section, I would like to discuss more about my teaching experience on the postgraduate taught module to demonstrate my reflection on teaching.

The process of teaching and learning are interconnected during the planning of learning activities. Satisfying students' learning needs was the core principle for my tutorial sessions design (Dagger, Wade, Conlan, & Society, 2005). Teaching needs to be learner-centered, transparent, encouraging deep learning. The design of the learning

activities shall help learners achieve specific learning outcomes using specific tools and resources, such as problem solving, arguments comparing and evaluating, etc. (Beetham, 2007). Facilitating wide range of skills were also considered in the design of learning activities, such as supporting learner discussion, giving relevant feedback, and most importantly, the ability to respond to learners' different needs (Beetham, 2007). The aim of the tutorial sessions was to help learners to develop their own research questions and choose the appropriate research designs in accordance with the research questions, which was based on Bloom's taxonomy (Krathwohl & Anderson, 2009), "applying" the prior knowledge (developing their own research questions and research designs) by understanding the existing research designs.

Students were quite satisfied with the tutorial sessions and after the sessions they were clear of the module aim and they were quite confident about what they needed to do next (developing research questions, developing correspondent research designs, etc.). One of the students told me that after several tutorial sessions she finally had a goal for her research, and she had a direction of how to achieve that. After finishing all the tutorial sessions, and evaluating my own tutorial session design, I realized that I could have utilized the learning design tools, which could potentially change the structure of learning activity (Griffiths, Blat, Garcia, Vogten, & Kwong, 2005). Undoubtedly, a clear teaching plan and targeted learning support for students were the most important aims for my tutorial session and more details on teaching and support of learning will be discussed as well.

Before the tutorial sessions, I would let students know what the schedule for the next tutorial session is by posting to the forum on DUO (Durham University Online). Several students even emailed me about the extra steps, which indicates that they were already enthusiastic about the tutorial sessions coming up. In the first session, I introduced myself and we had two warm-up activities just to get to know each other. Students just needed to scan the QR code or go to the URL to pin where they are from, and to type words on how they think of this module by using Poll Everywhere. Interestingly, most of them typed the word "difficult" when describing this module. In case of this, I encouraged them to ask questions to the group or to me anytime if they were confused about the key points in the sessions or contact me any time after the session (Michaelsen, Knight, & Fink, 2004).

When talking about different types of research designs and design notions, I would let them think about what kind of research designs and design notions they know, then I would explain the concepts according to their understanding. After the explanation, they had exercised on how to differentiate different research designs and how to describe different research designs with research notions for deep learning (Marton & Säljö, 1976). In the interactive stand-up and choose activity, students needed to stand up and choose a side for the following claims: "I develop my research questions before I conduct my research" or "I develop my research questions while I'm conducting my research". It was a good opportunity for students to have a relatively short break and move a little bit for the refresh, and it was quite interesting to see how students work on their research project and I gave them advice on these two different types of research styles.

In order to ensure that the students in the tutorial groups would benefit the most from the limited tutorial sessions, I intended to provide maximum support for students with their research designs. Emails, forums on DUO, one-on-one

individual tutorial sessions, social media are the main ways for me to support students after the tutorial sessions. The tutorial groups were female students predominant (only two male students in total), and most of them were Chinese students. Most of the students from tutorial groups were the first time studying in the UK, so me as a tutor for this module, had provided useful information regarding the study experience in UK and possible barriers in this module in particular as well. They could connect and message me on social media if they have any questions (Baird & Fisher, 2005). Several students came to me for further support, I had 30 minutes each for the one-on-one extra tutoring session. Hopefully, throughout the teaching practice and the teaching reflection, I would provide more efficient support to satisfy students' learning needs.

After the first tutorial session, I wrote the following reflection notes: "I think my overall rating of the session was 4 out of 5. I liked the interactive activities in the tutorial session and students were quite engaging in the activities. Students were quite supportive in my session since this was my first-time teaching in higher education and I was a little bit nervous and not showing much confidence on my teaching. I think I could improve my pace of the slides because I realized went through some of the slides really quickly and I didn't explain them well. I really need to talk to the module convener that more tutorial sessions are needed for the next cohort and they'll benefit more from these tutorial sessions." It was a quick note, but I hope it will remind me how could I improve my teaching in the future. After the completion of my teaching, I am still reflecting on the teaching by writing the teaching portfolio and thinking about the next steps for my professional development. Writing down the thoughts after teaching really helped me to reflect my teaching practice and hopefully, I could improve my expertise by being a reflective practitioner.

The reflection on my teaching in the postgraduate taught module had positive impact on my practice in the later undergraduate teaching assistant positions relating to research methods both in Business School and School of Education at Durham University. Also, as Microsoft Certified Trainer, I was honored to offer the Microsoft Office training session for university staff – First Steps with Excel – at Durham Centre for Academic Development. Later on, after the breakout of the pandemic, I was invited to be the co-convener of the MOOC Production: English Pedagogy in a higher institution in China.

6.2.2 MOOC Production: English Pedagogy

The development of modern educational technology provides new opportunities and challenges for the advancement of educational fields and development of English teachers. The outbreak of COVID-19 pandemic has spurred the development of online education. During the outbreak of the pandemic, most of the teaching and learning activities are conducted online. The MOOC course English Pedagogy is especially designed for English major students (Pre-service Teacher Education and Professional Development) specialized in English language teaching. English Pedagogy aims at providing students with an understanding of aspects in which English language learning takes place in classrooms, and an introduction of approaches and methods in language teaching and the methodology used in teaching English as a Foreign Language. By examining different methodologies and contexts students will be able to make informed decision about language teaching methods and techniques in English

language teaching. This course introduces and studies basic principles, approaches, and explanations of English language teaching. And a discussion of current topics in the English language teaching profession will also be included in this course. The course will act as an introduction for those new to the field or as a review for more experienced teachers. Also, it will discuss all aspects of language instruction, covering practical topics such as assessment and how to teach pronunciation, grammar, and vocabulary, how to teach listening, speaking, reading, and writing.

At the end of this course, pre-service teachers will be encouraged to reflect on their personal teaching and develop effective ways to become more reflective teachers. In addition to the theoretical knowledge, students will have a series of practical teaching activities such as teaching observation, lesson plan preparation, and teaching praxis. This would be the perfect time for students to improve their practical teaching capacity by applying the theoretical knowledge they have learned in this course. Therefore, this course aims to help students transit from the stage of teaching theory to the teaching practice smoothly. All the teaching and learning instructional videos and material has been recorded and uploaded to the Chinese University MOOC platform. The preparation of the MOOC started from August 2020 and it is expected to be published in 2021. I, as the co-convener of this course, have contributed more than a half teaching content including instructional videos and a variety of teaching and learning materials as required by the cooperation institution and the MOOC platform. The handbook for this MOOC represents the outcome of the development and the construction of the MOOC course English Pedagogy design process.

6.3 Reflective Practitioner and Professional Development

Reflection helps practitioners in developing self-knowledge, understanding the context in situations, and making principled and wise decisions. A reflective practitioner is also a professional practitioner, by being professionally self-critical without self-victimization (Ghaye, 2010). The context of the reflection can be rewarding, stimulating, and encouraging while others can be challenging, discouraging and complex. The process of reflection can be looking forward in order to achieve the future goals as “projection” or looking backwards to determine what have been achieved already and the tweaks for the past practice, as “review”. By appreciating what have done in the previous and the potential improvements in the future, I could learn more about myself, my job, my workplace, also the potentials for the future. Sometimes reflection is autonomous, intuitive and habitual, but in order to achieve certain goals, such as being a better practitioner and educator, I intend to reflect on my teaching practice in a conscious, deliberate and periodic way.

Schön (1983) has developed the ideas of reflection-in-action and reflection-on-practice, technical rationality, knowledge-in-action, the importance of re-framing practice. Reflection-in-action, or “rapid reflection” (Eraut, 1995), means by reflecting in a particular context or thinking about the heat of the moment. This can be unconscious and unaware and happens quickly. It is about improvisation, by making responsive tweaks, adaptations or adjustment in the midst of the practice or action. Reflection-on-practice is the reflection after the session by looking back and focusing on the significance, which is linked with the notion of time. It is selective and about the key things caught the attention and stayed in the memory. Technical rationality is a of view that teacher being a technician, the

professional practice is separated from the generation of knowledge. However, the technical-rational view is not compatible with the contested products of education, the usefulness of knowledge has been produced and applied, and the value of the skillfulness of knowledge-in-action. The knowing is often view as unconscious, tacit commonsense but it reveals itself in teaching practice. The knowledge-in-action describes the educator or teachers solving problem by developing their own theories about practice instead of by simply applying someone's else theory into our own practice. Reframing practice is a way to develop the professional expertise by seeing the same event from different standpoints and perspectives.

Dewey (1933) argued that reflection cannot be separated from experience in terms of two key elements. The first element of experience is continuity, which is the ability to connect the new experience to the aspects already known. Another element is interaction, which describes the continuity testing out and modifying the knowledge while interacting with others. Further, Dewey argued that the reflective process includes five steps: 1) "perplexity, confusion, doubt", 2) "conjectural anticipation and tentative interpretation", 3) "examination, inspection exploration, analysis of all attainable considerations", 4) "elaboration of the tentative hypothesis suggests", and 5) "a plan of action". Dewey also had a particular view of "problem" constitution; however, Loughran (2006) states that the word "problem" can itself be problematic. It has negative connotations, mistakes, and errors of judgment while "a situation that attracts attention; something that is curious or puzzling; something that invites further consideration beyond that which might initially have been anticipated" (Loughran, 2006, p. 45). Thus, the perceptible shift in the role of reflective practitioner should be non-deficit, joyful and encouraging.

I try to avoid the use of the word "problem" in my reflection process with regard to my reflection. I observe my situation with intense concentration and notice the encounters. Feedback is a good way to help reform the current situation. A good feedback contains a sense of positivity but presents the constraints as challenges. Reflection is not about righting the wrongs, fixing the negatives, or getting rid of problems; rather, it is by reducing the burdens by being "problematic" asking positive questions, as well as bringing forth future action for further achievement and greater promises. I often open up the opportunities for identifying the strength, celebratory aspects, and sustainable amplifiers instead of discouraging myself to the unlimited darkness. I prefer asking myself "How I can challenge myself next time?" instead of "What went wrong this time?". The questions I find particular useful for asking the challenges are "What might get in the way", "How could I reward myself for avoiding…", and "What do I need to change to enable me to tackle this important task?". The appreciation of the growth-based direction rather than focusing on deficit-based problems enables me to think more positively by flipping over perceptible shift of thinking, instead of ignoring problems.

In terms of my own professional development, I have had a detailed plan since my first year of EdD. For the last several years, I have participated in the following activities: 1) conference organization, presentation, and proceedings publication (Imagine Better Education at School of Education, Durham University, Year 2019 and Year 2018; Inaugural Interdisciplinary PGR Conference 2019 Global Challenges at Faculty of Social Sciences and Health, Durham University; CES PG Conference 2019 at University of Warwick; Cambridge Kaleidoscope 2019 at Faculty of Education, University of Cambridge); 2) DCAD training courses (Academic Skills, Digital Skills, Quantitative Methods,

Researcher Development, and Academic Language & Literacy, Publish or Perish); 3) career development training courses; 4) staff training sessions (physical and mental wellbeing, personal development, stress management, health and safety, coaching network, sexual violence & misconduct, disability awareness); 5) teaching and learning programs and workshops (TESOL and Durham University Excellence in Learning and Teaching Award courses, teaching induction and leadership workshops); 6) MOOCs learning (Fundamentals of Teaching and Learning Specialization, Coursera; Research Methods in Social Science Specialization, Coursera); 7) professional certificate (Associate Fellow of HEA, TESOL Certificate, Microsoft Office Specialist Master, Microsoft Certified Educator, Microsoft Certified Trainer, Microsoft Innovative Educator, First Aid at Work); 8) other forms of learning (reading books and papers, watching YouTube videos, seeking advice from experts, etc.)

Since teachers must have rich and flexible subject knowledge and the concepts of the discipline and the connections (C. Anderson, 1989; Ball, 1990). The key aspect of professional programs is to help teachers focus on the subject and the understanding of the connections (Borko, 2004). To have a well-developed subject knowledge and the concepts of the discipline, rich teaching experience and a well-developed professional development plan are essential for teachers to reach the next level of the teaching development. Studies show that the high-quality professional development involves the opportunities for teachers to engage in better teaching, better understanding of students, better students' achievement and even participation in leadership roles (Garet, Porter, Desimone, Birman, & Yoon, 2001; Hiebert, 1999). The participation of scholarly activities mentioned earlier has demonstrated my actively engagement in the professional development. Thus, the development as a teacher and the reflection on my teaching and learning experience have motivated me to focus more on not only being a reflective practitioner but also being a reflective researcher, and my understanding of research is getting more comprehensive and inclusive during my professional development progress.

7. Concluding Remarks

Three pieces of individual but closely connected studies were conducted for this thesis. The scoping review has employed a systematic approach to identify studies dealing with pre-service teachers' ICT beliefs. By uncovering a considerable volume of literature, outlining a framework of current existing literature, and extracting the key data and cataloged database of the literature in a comprehensive manner, it has revealed the crucial factors in terms of measuring pre-service teachers' ICT beliefs, explored unresolved issues with the current literature of pre-service teachers' beliefs of different technologies, provided clear directions for the development of further educational research and practice. Two research questions were answered by synthesizing the key data extracted from the selected studies in terms of the topic categories and the methodologies of the literature on pre-service teachers' ICT beliefs. These have added rigor to the scoping review process and thus serve as strengths. It also contributes to the methodological aspect of conducting the scoping review systematically by providing and expatiating the approaches adopted in the report, which could help move the relevant research field forward. Potential ICT training needs should be discussed for future studies to develop relevant professional training programs for pre-service teachers in order to move forward and make a difference in this research field. It is suggested that future research on pre-service teachers' ICT beliefs could be followed on the cutting-edge technologies, by providing comprehensive demographic information and research background, and contributing the analysis of corresponding training needs of these ICT tools.

This systematic review sought to examine the ICT beliefs of pre-service teachers containing the variables of ICT beliefs measurement, ICT adaptation factors and ICT training needs. Meta-analysis may need to be conducted to determine the significance of these variables on pre-service teachers' ICT beliefs in the future research. Also, it can be inferred that the main factors that affect pre-service teachers' adoption of ICT tools can be categorized to intrinsic and extrinsic factors, and the extrinsic factors potentially have major influence on their ICT adoption. Drawing upon the recommendations concerning the ICT training needs of pre-service teachers when investigating their ICT beliefs and perceptions, it is worthwhile paying special attention to the identification of training needs, the purpose of training, the training content, the training delivery methods, the partnership in training courses or programs, and the availability of follow-up in-service training. Stand-alone technology and technology integration courses can be both provided by educational technology specialists to offer pre-service teachers more choices and varieties of ICT training contents and opportunities. Nevertheless, there was no research in the included studies relating to pre-service teachers' beliefs and practice on the cutting-edge and the advanced technologies, such as virtual reality, augmented reality, etc. Besides, the conduction of scoping review and systematic review revealed the relevant literatures in current field and provide the insights into the possible ways to measure pre-service teachers' ICT beliefs.

A mixed method empirical study on pre-service teachers' beliefs and training needs on the educational use of virtual reality was conducted to fill this research gap and move the literature forward, as the results of scoping review and systematic review have suggested that there is a lack of evidence about pre-service teachers' beliefs on cutting-edge

technologies, such as virtual reality technology. This empirical research aimed to explore pre-service English teachers' perception of VR technology and their training needs in China, by investigating the status quo of ICT use in the classroom and the potential implementation of VR in teaching and learning. It was found that pre-service teachers have moderate positive attitude towards ICT and virtual reality technology in terms of openness to new ICT tools, perceived usefulness, perceived ease of use, and technological complexity; however, they hold a relative positive expectation and future development of virtual reality technology in the educational field. The result also showed that pre-service teachers have moderate attitude towards ICT training, and they have clear goals on their training needs to guide their implementation of virtual reality technology in classroom teaching and learning. It is suggested that pre-service teachers in China need to adapt to the recent and newest policies for their own development and for the society advancement. Future research could be based on the relationship between pre-service teachers' ICT beliefs and the practices of integration of technology in the classroom, as well as the changes of pre-service teachers' perception on ICT before and after Covid-19 pandemic with teaching practice.

The significance of the study lies in the adoption of systematic review methodologies and the transparency of the conduct of the initial scoping review and the systematic review in relation to pre-service teachers' ICT beliefs in educational studies. This addresses a particular research gap in this area and moves the literature forward by synthesising the existing research to date in relation to the nature of this research and its findings about pre-service teachers' beliefs about ICT. In addition, the empirical study has contributed research evidence about pre-service teachers' perceptions of virtual reality as a potential educational tool in China by relating this to the policies related to Teacher Education and Education Informatization. The empirical study therefore also builds directly on the systematic review. Based on the empirical evidence from this research, policymakers in China can optimize current Teacher Education and Education Informatization policies as a guidance for developing a smart plan and a wise pathway for pre-service teachers' cultivation and education in China, which would also contribute to the plan of sustainable and efficient way to cling to the country's strategy of development and prosperity.

Approaching to the end of my professional doctorate journey, I am so proud that I have produced three closely connected research studies by adopting scoping review, systematic review, and mixed methods research into one piece of a professional doctorate thesis. I am also proud of my rich experience on teaching and learning that deserves a chapter of reflection for my future action. The completion of this thesis has marked the milestone of my life; also, it is an initial step towards being a matured man and an independent individual.

References

A, L. (2006a). Chinese Electronic Education Chronology, Part 1. [中国电化教育(教育技术)年表(一)(第一部分,1920年-1948 年)]. *e-Education Research*(11), 78-80.

A, L. (2006b). Chinese Electronic Education Chronology, Part 2. [中国电化教育(教育技术)年表(二)]. *e-Education Research*(12), 63-70.

Akbulut, Y. (2009). Investigating underlying components of the ICT indicators measurement scale: the extended version. *Journal of Educational Computing Research, 40*(4), 405-427.

Akbulut, Y., Odabasi, H. F., & Kuzu, A. (2011). PERCEPTIONS OF PRESERVICE TEACHERS REGARDING THE INTEGRATION OF INFORMATION AND COMMUNICATION TECHNOLOGIES IN TURKISH EDUCATION FACULTIES. *Turkish Online Journal of Educational Technology, 10*(3), 175-184.

Akkaya, R. (2016). Research on the Development of Middle School Mathematics Pre-Service Teachers' Perceptions Regarding the Use of Technology in Teaching Mathematics. *EURASIA Journal of Mathematics, Science & Technology Education, 12*(4), 861-879.

Al-Awidi, H. M., & Alghazo, I. M. (2012). The effect of student teaching experience on preservice elementary teachers' self-efficacy beliefs for technology integration in the UAE. *Educational Technology Research and Development, 60*(5), 923-941.

Albion, P. R., Jamieson-Proctor, R., & Finger, G. (2011). Age-related differences in ICT access and confidence among pre-service teachers. 21-32.

Albirini, A. (2006). Teachers' attitudes toward information and communication technologies: The case of Syrian EFL teachers. *Computers & Education, 47*(4), 373-398.

Alblaihed, M. A. (2016). Saudi arabian science and mathematics pre-service teachers' perceptions and practices of the integration of technology in the classroom. *10596053*.

Alkan, F., & Erdem, E. (2010). The attitudes of student teachers towards educational technologies according to their status of receiving teaching application lessons. *Procedia - Social and Behavioral Sciences, 2*(2), 2523-2527. doi:https://doi.org/10.1016/j.sbspro.2010.03.366

Allsopp, D. H., McHatton, P. A., & Cranston-Gingras, A. (2009). Examining Perceptions of Systematic Integration of Instructional Technology in a Teacher Education Program. *Teacher Education and Special Education, 32*(4), 337-350.

Anderson, C. (1989). The role of education in the academic disciplines in teacher preparation dalam Woolfolk (Eds), Research perspectives on the graduate preparation of teacher. In: Englewood Cliffs, NJ: Prentice.

Anderson, S., Allen, P., Peckham, S., & Goodwin, N. (2008). Asking the right questions: scoping studies in the commissioning of research on the organisation and delivery of health services. *Health research policy and systems, 6*(1), 1-12.

Angeli, C. (2004). The Effects of Case-Based Learning on Early Childhood Pre-Service Teachers' Beliefs about the Pedagogical Uses of ICT. *Journal of Educational Media, 29*(2), 139-151.

Arksey, H., & Knight, P. T. (1999). *Interviewing for social scientists: An introductory resource with examples*: Sage.

Arksey, H., & O'Malley, L. (2005). Scoping studies: towards a methodological framework. *International Journal of Social Research Methodology, 8*(1), 19-32. doi:10.1080/1364557032000119616

Armstrong, R., Hall, B. J., Doyle, J., & Waters, E. (2011). 'Scoping the scope'of a cochrane review. *Journal of public health*, *33*(1), 147-150.

Aromataris, E., & Pearson, A. (2014). The systematic review: an overview. *AJN The American Journal of Nursing, 114*(3), 53-58.

Baird, D. E., & Fisher, M. J. J. o. e. t. s. (2005). Neomillennial user experience design strategies: Utilizing social networking media to support "always on" learning styles. *34*(1), 5-32.

Balcin, M. D., Ari, E., Erdogan, Y., & Besoluk, S. (2014). Analysis of self-efficacy perception of the science teacher candidates intended for information technology: Example of Sakarya University faculty of education. *152*, 679-685. doi:10.1016/j.sbspro.2014.09.262

Ball, D. L. (1990). The mathematical understandings that prospective teachers bring to teacher education. *The elementary school journal*, *90*(4), 449-466.

Bansilal, S. (2015). Exploring Student Teachers' Perceptions of the Influence of Technology in Learning and Teaching Mathematics. *South African Journal of Education, 35*(4).

Barak, M. (2014). Closing the Gap Between Attitudes and Perceptions About ICT-Enhanced Learning Among Pre-service STEM Teachers. *Journal of Science Education and Technology, 23*(1), 1-14.

Basoz, T., Cubukcu, F., Laborda, J. C., Ozdamli, F., & Maasoglu, Y. (2014). Pre-service EFL teachers' attitudes towards Computer Assisted Language Learning (CALL). *116*, 531-535. doi:10.1016/j.sbspro.2014.01.253

Bassey, M. (1999). *Case study research in educational settings*: McGraw-Hill Education (UK).

Baturay, M. H., Gökçearslan, Ş., & Ke, F. (2017). The relationship among pre-service teachers' computer competence, attitude towards computer-assisted education, and intention of technology acceptance. *International Journal of Technology Enhanced Learning, 9*(1), 1-13. doi:10.1504/IJTEL.2017.084084

Baz, E. H. (2016). Attitudes of Turkish EFL Student Teachers towards Technology Use. *Turkish Online Journal of Educational Technology - TOJET, 15*(2), 1-10.

Beacham, N., & McIntosh, K. (2014). Student teachers' attitudes and beliefs towards using ICT within inclusive education and practice. *Journal of Research in Special Educational Needs, 14*(3), 180-191. doi:10.1111/1471-3802.12000

Beetham, H. (2007). An approach to learning activity design. In *Rethinking pedagogy for a digital age* (pp. 46-60): Routledge.

Best, L. M., & Tidwell, M. G. (2002). Comparison of the perceptions of university faculty and pre -service students' technology skills and integration of technology in selected elementary education courses. *3045741*, 380.

Biocca, F. (1997). The Cyborg's Dilemma: Progressive Embodiment in Virtual Environments [1]. *Journal of Computer‐Mediated Communication, 3*(2), 0-0. doi:10.1111/j.1083-6101.1997.tb00070.x

Birkollu, S. S., Yucesoy, Y., Baglama, B., & Kanbul, S. (2017). Investigating the attitudes of pre-service teachers towards technology based on various variables. *TEM Journal*, *6*(3), 578.

Bolandifar, S., & Noordin, N. (2015). Computer anxiety and attitudes toward using internet in english language classes among iranian postgraduate student teachers. *23*(2), 355-374.

Borko, H. J. E. r. (2004). Professional development and teacher learning: Mapping the terrain. *33*(8), 3-15.

Botella, C., García‐Palacios, A., Villa, H., Baños, R. M., Quero, S., Alcañiz, M., & Riva, G. (2007). Virtual reality exposure in the treatment of panic disorder and agoraphobia: A controlled study. *Clinical Psychology & Psychotherapy, 14*(3), 164-175. doi:10.1002/cpp.524

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative research in psychology, 3*(2), 77-101.

Brien, S. E., Lorenzetti, D. L., Lewis, S., Kennedy, J., & Ghali, W. A. (2010). Overview of a formal scoping review on health system report cards. *Implementation Science*, *5*(1), 1-12.

Brooks, R., Te Riele, K., & Maguire, M. (2014). *Ethics and education research*: Sage.

Browne, J. (2009). Assessing Pre-Service Teacher Attitudes and Skills with the Technology Integration Confidence Scale. *Computers in the Schools, 26*(1), 4-20.

Bruce, C., & Gerber, R. (1995). Towards university lectures' conceptions of student learning. *Higher Education, 29*(4), 443-458.

Bruckman, A., & Resnick, M. (1995). The MediaMOO project: Constructionism and professional community. *Convergence, 1*(1), 94-109.

Burdea, G., & Coiffet, P. (2003). Virtual Reality Technology. *Presence: Teleoperators & Virtual Environments, 12*(6), 663-664. doi:10.1162/105474603322955950

Cai. (2019). Reform on the Road: Reflections on the Construction of Teacher Education System with Chinese Characteristics. [改革在路上:中国特色教师教育体系建设之省思]. *Jiangsu Higher Education, 000*(012), 30-40.

Can, S. (2015). Investigation of Pre-Service Physical Education Teachers' Attitudes Towards Computer Technologies (Case of Turkey). *Educational Research and Reviews, 10*(4), 485-490.

Can, S. (2016). The attitudes of pre-service teachers attending the schools of physical education and sports of the universities in Turkey towards education technologies. *Anthropologist, 23*(3), 513-521.

Can, S., & Uzunboylu, H. (2010). Comparison of the attitudes of the pre-service teachers from SESMTE and SESSTE departments against computer use (The case of Mugla University, Turkey). *2*(2), 4638-4642. doi:10.1016/j.sbspro.2010.03.742

Carr, K., & England, R. (1995). *Simulated and virtual realities: Elements of perception*: CRC Press.

Cavas, B., Cavas, P., Karaoglan, B., & Kisla, T. (2009). A Study on Science Teachers' Attitudes Toward Information and Communications Technologies in Education. *Online Submission, 8*(2).

CELTSC, C. E. T. S. C. (1999). Chinese E-Learning Technology Standards.

Chai, C. S., Hong, H. Y., & Teo, T. (2009). Singaporean and Taiwanese pre-service teachers' beliefs and their attitude towards ICT use: A comparative study. *Asia-Pacific Education Researcher, 18*(1), 117-128.

Chai, C. S., Wong, B., & Teo, T. (2011). Singaporean Pre-Service Teachers' Beliefs about Epistemology, Teaching and Learning, and Technology. *Teacher Development, 15*(4), 485-498.

Chan, K.-W., & Elliott, R. G. (2004). Relational analysis of personal epistemology and conceptions about teaching and learning. *Teaching and teacher education, 20*(8), 817-831.
Charmaz, K. (2014). *Constructing grounded theory*: sage.
Chen, & Wang, J. (2002). The Development of Education Informatization and Our Mission. [我国教育信息化理论研究新进展]. *Journal of Nanjing Normal University (Natural Science Edition)*(S1), 30-32.
Chen, L., Chen, Y., Zheng, X., & Li, Z. (2015). Intelligent Education Led by China. [智慧教育 中国引领]. *e-Education Research*(4), 23-27.
Chen, L., Li, B., Huang, W., Li, P., & Wang, W. (2016). New Development of Chinese Educational Informationization on the Twentieth Anniversary - Interpretation of the Top Chinese Ten News of 2015 in Educational Informationization. [中国教育信息化 20 大庆之年新发展——2015 年中国教育信息化十大新闻解读]. *Educational Informatization*(02), 80-87.
Chen, L., & Li, Z. (2014). Interpretation of the Top Ten News of Educational Informationization in China 2013. [2013 年中国教育信息化十大新闻解读]. *China Educational Technology*(3), 38-41.
Chisalita, O., Cretu, C., Frunzeti, T., Jugureanu, R., Ciolan, L., & Radu, C. (2012). OPINIONS AND ATTITUDES OF STUDENTS TEACHERS' TOWARD ICT USE IN EDUCATION. 548-553. doi:10.5682/2066-026x-12-179
Çiftci, S., & Aladag, S. (2018). An Investigation of Pre-Service Primary School Teachers' Attitudes towards Digital Technology and Digital Citizenship Levels in Terms of Some Variables. *International Education Studies, 11*(1), 111-118.
Cobanoglu, I., Ates, A., Ilic, U., Yilmaz, E., Uzunboylu, H., & Cavus, N. (2009). Investigating prospective computer teachers' perceptions on e-learning. *1*(1), 1460-1463. doi:10.1016/j.sbspro.2009.01.257
Cohen, L. (2018). *Research methods in education* (Eighth edition. ed.): London, England
Cohen, L., Manion, L., & Morrison, K. (2017). *Research methods in education*: London: Routledge.
Colquhoun, H. L., Levac, D., O'Brien, K. K., Straus, S., Tricco, A. C., Perrier, L., . . . Moher, D. (2014a). Scoping reviews: time for clarity in definition, methods, and reporting. *Journal of clinical epidemiology, 67*(12), 1291-1294.
Colquhoun, H. L., Levac, D., O'Brien, K. K., Straus, S., Tricco, A. C., Perrier, L., . . . Moher, D. J. J. o. c. e. (2014b). Scoping reviews: time for clarity in definition, methods, and reporting. *67*(12), 1291-1294.
Constantin, P., & Sgem. (2014). THE PERCEPTION OF THE PHYSICAL EDUCATION TEACHERS CONCERNING THE USE OF THE AUDIOVISUAL TECHNOLOGIES IN SHAPING THE MOTOR SKILLS. 949-955.
Creswell, J. W., & Clark, V. L. P. (2017). *Designing and conducting mixed methods research*: Sage publications.
Creswell, J. W., & Creswell, J. D. (2017). *Research design: Qualitative, quantitative, and mixed methods approaches*: Sage publications.
Dagger, D., Wade, V., & Conlan, O. (2005). Personalisation for all: Making adaptive course composition easy. *Journal of Educational Technology & Society*, *8*(3), 9-25.
Daudt, H. M., van Mossel, C., & Scott, S. J. (2013). Enhancing the scoping study methodology: a large, inter-professional team's experience with Arksey and O'Malley's framework. *BMC medical research methodology, 13*(1), 48.
Davis, F. D. (1989). Perceived usefulness, perceived ease of use, and user acceptance of information technology. *MIS quarterly*, 319-340.
Delaney, S., Trapani, F., Chandler, P., Redman, C., Chova, L. G., Martinez, A. L., & Torres, I. C. (2014). CONTEMPORARY PRACTICES OF TECHNOLOGY AND ITS AFFORDANCES: PERCEPTIONS OF PRE-SERVICE TEACHERS ON THE UTILIZATION OF TECHNOLOGY IN TEACHING AND LEARNING PRACTICE. 2472-2481.
Deng, F., Chai, C. S., Chin-Chung, T., & Min-Hsien, L. (2014). The relationships among Chinese practicing teachers' epistemic beliefs, pedagogical beliefs and their beliefs about the use of ICT. *Journal of Educational Technology & Society, 17*(2), 245.
Denscombe, M. (2017). *EBOOK: The Good Research Guide: For Small-Scale Social Research Projects*: McGraw-Hill Education (UK).
Dewey, J. (1933). *How we think: A restatement of the relation of reflective thinking to the educative process*: DC Heath.
Dogan, M., Yang, W. C., Majewski, M., De Alwis, T., & Karakirk, E. (2011). *TRAINEE TEACHERS' ATTITUDES ABOUT MATERIALS AND TECHNOLOGY USE IN MATHEMATICS EDUCATION*. Blacksburg: Mathematics & Technology, Llc.
DuBay, T. L., & Gredler, M. (2001). *Impact of a verbal persuasion treatment on teacher education students' attitudes and self-efficacy for computer technology.* (3013419). University of South Carolina, Ann Arbor.

Duru, A., Peker, M., & Birgin, O. (2012). Investigation of Pre-Service Teachers' Attitude s toward Using the Computer in Teaching and Learning Mathematics. *The New Educational Review, 27*(1), 283-294.
Efe, H. A., Efe, R., & Yücel, S. (2016). A Comparison of Swiss and Turkish Pre-Service Science Teachers' Attitudes, Anxiety and Self-Efficacy Regarding Educational Technology. *Universal Journal of Educational Research, 4*(7), 1583-1594.
EPPI. (2003). Guidelines for extracting data and quality assessing primary studies in educational research Version 0.9.7.
Eraut, M. (1995). Schon Shock: a case for refraining reflection-in-action?. *Teachers and teaching*, *1*(1), 9-22.
Ertmer, P. A. (1999). Addressing first- and second-order barriers to change: Strategies for technology integration. *Educational Technology Research and Development, 47*(4), 47-61. doi:10.1007/bf02299597
Esposito, N. (2001). From meaning to meaning: The influence of translation techniques on non-English focus group research. *Qualitative health research, 11*(4), 568-579.
Eyyam, R., Menevis, I., Dogruer, N., Osam, U. V., Vefali, G. M., Kufi, E. O., & Arkin, E. I. (2010). Perceptions of prospective teachers towards technology use in class. *3*, 88-93. doi:10.1016/j.sbspro.2010.07.016
Findikoglu, F., Alci, B., & Karatas, H. (2015). The correlation between pre-service teachers' attitudes towards technology and achievement in material design course. *Anthropologist, 20*(3), 744-753.
Fink, A. (2005). *Conducting research literature reviews: From the internet to paper*: Sage.
Fluck, A., & Dowden, T. (2013). On the Cusp of Change: Examining Pre-Service Teachers' Beliefs about ICT and Envisioning the Digital Classroom of the Future. *Journal of Computer Assisted Learning, 29*(1), 43-52.
Foster, D., & Meech, J. F. (1995). Social dimensions of virtual reality.
Funkhouser, B. J., & Mouza, C. (2013). Drawing on technology: An investigation of preservice teacher beliefs in the context of an introductory educational technology course. *Computers & Education, 62*, 271-285. doi:https://doi.org/10.1016/j.compedu.2012.11.005
Gaggioli, A., Pallavicini, F., Morganti, L., Serino, S., Scaratti, C., Briguglio, M., . . . Riva, G. (2014). Experiential virtual scenarios with real-time monitoring (interreality) for the management of psychological stress: a block randomized controlled trial. *Journal of medical Internet research, 16*(7), e167. doi:10.2196/jmir.3235
Garet, M. S., Porter, A. C., Desimone, L., Birman, B. F., & Yoon, K. S. J. A. e. r. j. (2001). What makes professional development effective? Results from a national sample of teachers. *38*(4), 915-945.
Gay, L. R., Mills, G. E., & Airasian, P. W. (2011). *Educational research: Competencies for analysis and applications*: Pearson Higher Ed.
Gerardi, M., Rothbaum, B. O., Ressler, K., Heekin, M., & Rizzo, A. (2008). Virtual reality exposure therapy using a virtual Iraq: Case report. *Journal of Traumatic Stress, 21*(2), 209-213. doi:10.1002/jts.20331
Ghaye, T. (2010). *Teaching and learning through reflective practice: A practical guide for positive action*: Routledge.
Giavrimis, P., Giossi, S., & Papastamatis, A. (2011). Teachers' attitudes towards training in ICT: a critical approach. *Quality Assurance in Education, 19*(3), 283-296.
Gilbert, T. J. J. o. r. i. n. (2006). Mixed methods and mixed methodologies: The practical, the technical and the political. *11*(3), 205-217.
Giles, L. M., & Tyler-Wood, T. (2016). The impact of a paired grouping pre-service technology integration course on student participant attitudes, proficiency, and technological knowledge toward technology. *10307510*, 127.
Glaser, B. G., Strauss, A. L., & Strutzel, E. (1968). The discovery of grounded theory; strategies for qualitative research. *Nursing research, 17*(4), 364.
Gok, B., & Erdogan, T. (2010). INVESTIGATION OF PRE-SERVICE TEACHERS' PERCEPTIONS ABOUT CONCEPT OF TECHNOLOGY THROUGH METAPHOR ANALYSIS. *Turkish Online Journal of Educational Technology, 9*(2), 145-160.
Goktas, Y., & Demirel, T. (2012). Blog-Enhanced ICT Courses: Examining Their Effects on Prospective Teachers' ICT Competencies and Perceptions. *Computers & Education, 58*(3), 908-917.
Gomez, J. R., Garrett, S. D., & Kouzekanani, K. (2016). Comparison of pre-service and in-service teachers' attitudes and perceived abilities toward integrating digital technologies into the classroom. *10244087*, 132.
Gough, D. (2007). Weight of evidence: a framework for the appraisal of the quality and relevance of evidence. *Research papers in education, 22*(2), 213-228.
GOV. (2015). Government Work Report.
GOV. (2018). Comprehensively deepening the reform of the construction of the teaching staff in the new era.
Grant, M. J., & Booth, A. (2009). A typology of reviews: an analysis of 14 review types and associated methodologies. *Health Information & Libraries Journal, 26*(2), 91-108.
Gray, D. E. (2013). *Doing research in the real world*: Sage.

Greene-Clemons, C. D. (2016). Perceptions of Technology Engagement on Culturally Responsive Pre-Service Teachers. *Journal for Multicultural Education, 10*(3), 339-353.
Griffiths, D., Blat, J., Garcia, R., Vogten, H., & Kwong, K. (2005). Learning design tools. In *Learning design* (pp. 109-135): Springer.
Gu, Hao, & Hu. (2017). To Enhance the Characteristics and Advantages of Normal Education in China: An Interview with Canadian and American Scholars. [重建师范教育——访顾明远先生]. *Contemporary Teacher Education*(1).
Gunes, E., & Bahcivan, E. (2018). A mixed research-based model for pre-service science teachers' digital literacy: Responses to "which beliefs" and "how and why they interact" questions. *Computers & Education, 118*, 96-106. doi:10.1016/j.compedu.2017.11.012
Gungoren, O. C., & Horzum, M. B. (2015). Modeling pre-service teachers' perception of future internet usage for professional educational purposes. *17*(3), 815-834. doi:10.15516/cje.v17i3.1132
Gurcay, D., Wong, B., & Chai, C. S. (2013). Turkish and Singaporean Pre-service Physics Teachers' Beliefs about Teaching and Use of Technology. *Asia-Pacific Education Researcher, 22*(2), 155-162. doi:10.1007/s40299-012-0008-2
Gyamfi, S. A. (2017). Pre-Service Teachers' Attitude towards Information and Communication Technology Usage: A Ghanaian Survey. *International Journal of Education and Development using Information and Communication Technology, 13*(1), 52-69.
Halfhill, T. R. (1996). Agents and avatars. *Byte, 21*(2), 69-71.
Hamit, F. (1994). *Virtual reality and the exploration of cyberspace*: Sams.
Hammersley, M. (2009). Against the ethicists: on the evils of ethical regulation. *International Journal of Social Research Methodology, 12*(3), 211-225.
Harden, A., & Thomas, J. (2010). Mixed methods and systematic reviews: Examples and emerging issues. *Sage handbook of mixed methods in social & behavioral research, 2*, 749-774.
Hart, C. (1998). *Doing a literature review: Releasing the social science research imagination*: Sage.
Hartas, D. (2015). *Educational research and inquiry: Qualitative and quantitative approaches*: Bloomsbury Publishing.
Hazzan, O. (2002). Prospective high school mathematics teachers' attitudes toward integrating computers in their future teaching. *Journal of Research on Technology in Education, 35*(2), 213-225. doi:10.1080/15391523.2002.10782381
He, K. (2011). The Latest Education Informatization Theory in China. [我国教育信息化理论研究新进展]. *China Educational Technology*(1), 1-19.
Hiebert, J. J. J. f. r. i. m. e. (1999). Relationships between research and the NCTM standards. *30*(1), 3.
Higgins, J. P., Thomas, J., Chandler, J., Cumpston, M., Li, T., Page, M. J., & Welch, V. A. (2019). *Cochrane handbook for systematic reviews of interventions*: John Wiley & Sons.
Hills, P., & Argyle, M. (2003). Uses of the Internet and their relationships with individual differences in personality. *Computers in Human Behavior, 19*(1), 59-70.
Hismanoglu, M. (2012a). The Impact of a Curricular Innovation on Prospective EFL Teachers' Attitudes towards ICT Integration into Language Instruction. *Online Submission*.
Hismanoglu, M. (2012b). Prospective EFL Teachers' Perceptions of ICT Integration: A Study of Distance Higher Education in Turkey. *Educational Technology & Society, 15*(1), 185-196.
Hu, X.-Q., Su, R., & He, L. (2016). *The Research on Chinese Idioms Educational Games in TCFL Based on Virtual Reality.* Paper presented at the ITM Web of Conferences.
Huang, C.-H., & McNeil, S. (2003). Impact of socially desirable instrumentality and socially desirable expressiveness on female pre -service teachers' computer attitudes. *3081492*, 113.
Huang, C. (2014). A needs analysis for Chinese language teaching at a university in the United States. *Language Learning in Higher Education, 4*(2), 395-422.
Inan, F. A., & Lowther, D. L. (2010). Factors affecting technology integration in K-12 classrooms: a path model. *Educational Technology Research and Development, 58*(2), 137-154. doi:10.1007/s11423-009-9132-y
Incik, E. Y., & Akay, C. (2017). A Comprehensive Analysis on Technopedagogical Education Competency and Technology Perception of Pre-Service Teachers: Relation, Levels and Views. *Contemporary Educational Technology, 8*(3), 232-248.
Ipek, A. S., Berigel, M., & Albayrak, M. (2007). *Prospective Mathematics Teachers' Attitudes Towards Learning Mathematics with Technology*.

Işikgöz, E. (2016). The relation between the attitudes of pre-service physical education teachers towards instructional technologies and material design course and their academic standing: Batman university sample. *Turkish Online Journal of Educational Technology, 2016*(DecemberSpecialIssue), 1046-1052.
Jacobs, A. (2013). Two cheers for Web U. *New York Times, 162*(56,113), 1-7.
Jou, M., & Wang, J. (2013). Investigation of effects of virtual reality environments on learning performance of technical skills. *Computers in Human Behavior, 29*(2), 433-438.
Jung, E., Rhodes, D. M., & Vogt, W. P. (2006). Disposition assessment in teacher education: A framework and instrument for assessing technology disposition. *The Teacher Educator, 41*(4), 207-233.
Jung, E. J., & Rhodes, D. M. (2004). Technology disposition of teacher education students: Beliefs, attitudes, self-concepts, and competence. *3172878*, 143.
Kabadayi, A. (2006). Analyzing Pre-School Student Teachers' and Their Cooperating Teachers' Attitudes towards the Use of Educational Technology. *Turkish Online Journal of Educational Technology - TOJET, 5*(4), 3-10.
Kalogiannakis, M. (2010). Training with ICT for ICT from the trainee's perspective. A local ICT teacher training experience. *Education and Information Technologies, 15*(1), 3-17.
Karatas, I. (2014). Changing Pre-Service Mathematics Teachers' Beliefs about Using Computers for Teaching and Learning Mathematics: The Effect of Three Different Models. *European Journal of Teacher Education, 37*(3), 390-405.
Karr, D. L., & Steckelberg, A. (2014). Attitudes and beliefs student teachers hold toward technology integration. *3665955*, 103.
Kaya, S., & Durmus, A. (2011). Investigation Of Relationship Between Preservice Teachers' Unethical Computer Using Behavior And Attitudes Towards The Using Of Internet. *Procedia - Social and Behavioral Sciences, 28*, 667-672. doi:https://doi.org/10.1016/j.sbspro.2011.11.126
Keele, S. (2007). Guidelines for performing systematic literature reviews in software engineering. In *Technical report, Ver. 2.3 EBSE Technical Report. EBSE*: sn.
Keser, H., Karaoglan Yilmaz, F. G., & Yilmaz, R. (2015). TPACK Competencies and Technology Integration Self-Efficacy Perceptions of Pre-Service Teachers. *Online Submission*.
Keskitalo, T. (2011). Teachers' Conceptions and Their Approaches to Teaching in Virtual Reality and Simulation-Based Learning Environments. *Teachers and Teaching: Theory and Practice, 17*(1), 131-147. doi:10.1080/13540602.2011.538503
Kinzie, M. B., & Delcourt, M. A. (1991). Computer technologies in teacher education: The measurement of attitudes and self-efficacy.
Kinzie, M. B., Delcourt, M. A., & Powers, S. M. (1994). Computer technologies: Attitudes and self-efficacy across undergraduate disciplines. *Research in higher education, 35*(6), 745-768.
Knott, B. A. (2000). *Learning route and survey representations from a virtual reality environment*: The Catholic University of America.
Kobak, M., & Taskin, N. R. (2012). Prospective Teachers' Perceptions of using Technology in Three Different Ways. *Procedia - Social and Behavioral Sciences, 46*, 3629-3636. doi:https://doi.org/10.1016/j.sbspro.2012.06.118
Koc, M., & Bakir, N. (2010). A Needs Assessment Survey to Investigate Pre-Service Teachers' Knowledge, Experiences and Perceptions about Preparation to Using Educational Technologies. *Turkish Online Journal of Educational Technology - TOJET, 9*(1), 13-22.
Koksal, M. S., Yaman, S., & Saka, Y. (2016). Analysis of Turkish Prospective Science Teachers' Perceptions on Technology in Education. *Australian Journal of Teacher Education, 41*(1).
Kong, F. (2003). *A Theoretic Research and Empiric Analysis on Higher Educational Informatization.* Wuhan University of Technology,
Krathwohl, D. R., & Anderson, L. W. (2009). *A taxonomy for learning, teaching, and assessing: A revision of Bloom's taxonomy of educational objectives*: Longman.
Kubiatko, M., & Haláková, Z. (2009). Slovak high school students' attitudes to ICT using in biology lesson. *Computers in Human Behavior, 25*(3), 743-748.
Kuo, M.-M. (2008). *Learner to Teacher: EFL Student Teachers' Perceptions on Internet-Assisted Language Learning and Teaching*.
Laksov, K. B., Lonka, K., & Josephson, A. (2008). How do medical teachers address the problem of transfer? *Advances in Health Sciences Education, 13*(3), 345-360.
Lam, M. K., Nguyen, M., Lowe, R., Nagarajan, S. V., & Lincoln, M. (2014). *" I can do it": Does confidence and perceived ability in learning new ICT skills predict pre-service health professionals' attitude towards engaging in e-healthcare?* Paper presented at the HIC.

Lee, D., Kang, J., Mitra, P., Giles, C. L., & On, B.-W. (2007). Are your citations clean? *Communications of the ACM, 50*(12), 33-38.
Lee, Y., & Lee, J. (2014). Enhancing pre-service teachers' self-efficacy beliefs for technology integration through lesson planning practice. *Computers & Education, 73*, 121-128. doi:https://doi.org/10.1016/j.compedu.2014.01.001
Levac, D., Colquhoun, H., & O'Brien, K. K. (2010). Scoping studies: advancing the methodology. *Implementation science, 5*(1), 1-9.
Li, K. (2004). Education Informatization and Basic Education Reform. [教育信息化与基础教育改革]. *Guangxi Education*(6B), 20-22.
Liberati, A., Altman, D. G., Tetzlaff, J., Mulrow, C., Gøtzsche, P. C., Ioannidis, J. P., . . . Moher, D. (2009). The PRISMA statement for reporting systematic reviews and meta-analyses of studies that evaluate health care interventions: explanation and elaboration. *Journal of clinical epidemiology, 62*(10), e1-e34.
Lin, Y. H., & Liang, J. C. (2012). Preschool teachers' internet attitude and their internet self-efficacy: A comparative study between pre-service and in-service teachers in taiwan. 334-339. doi:10.1109/IIAI-AAI.2012.72
Little, D. (1995). Learning as dialogue: The dependence of learner autonomy on teacher autonomy. *System, 23*(2), 175-181.
Little, D. (2007). Language learner autonomy: Some fundamental considerations revisited. *International Journal of Innovation in Language Learning and Teaching, 1*(1), 14-29.
Little, D., & Brammerts, H. (1996). A Guide to Language Learning in Tandem via the Internet. CLCS Occasional Paper No. 46.
Liu, D., & Li, J. (2002). About Education Informatization - Perspectives from Dr. Li Jiahou. [黎加厚博士谈教育信息化]. *China Educational Technology*(1), 5-8.
Liu, Y. (2016). A Study of ICT Policies in the Basic Education of China. [对我国基础教育信息化政策的梳理与思考]. *Theory and Practice of Education*(4), 30-33.
Lonka, K., Joram, E., & Bryson, M. (1996). Conceptions of learning and knowledge: does training make a difference? *Contemporary Educational Psychology, 21*(3), 240-260.
Loughran, J. (2006). A response to 'Reflecting on the self'. *7*(1), 43-53.
Loyd, B. H., & Gressard, C. (1984). Reliability and factorial validity of computer attitude scales. *Educational and psychological measurement, 44*(2), 501-505.
Lu, L.-F. L. (2005). Pre-Service Art Teacher Negative Attitudes and Perceptions of Computer-Generated Art Imagery: Recommendations for Pre-Service Art Education Programs. *Visual Arts Research, 31*(1), 89-102.
Lü, Y. (2004). Abundant Availability of Information in Education and Its Ethical Control. [教育的信息化及其道德控制]. *Education and Modernization*(1), 3-8.
Lune, H., & Berg, B. L. (2017). *Qualitative research methods for the social sciences*: Pearson.
Mahmood, K., & Ajmal Khan, M. (2007). ICT training for LIS professionals in Pakistan: A needs assessment. *Program, 41*(4), 418-427.
Makki, T. W., O'Neal, L. J., Cotten, S. R., & Rikard, R. V. (2018). When first-order barriers are high: A comparison of second- and third-order barriers to classroom computing integration. *Computers & Education, 120*, 90-97. doi:https://doi.org/10.1016/j.compedu.2018.01.005
Marton, F., & Säljö, R. J. B. j. o. e. p. (1976). On qualitative differences in learning: I—Outcome and process. *46*(1), 4-11.
Maxwell, J. A. (2012). *Qualitative research design: An interactive approach* (Vol. 41): Sage publications.
McCann, R. A., Armstrong, C. M., Skopp, N. A., Edwards-Stewart, A., Smolenski, D. J., June, J. D., . . . Reger, G. M. (2014). Virtual reality exposure therapy for the treatment of anxiety disorders: An evaluation of research quality. *Journal of anxiety disorders, 28*(6), 625-631. doi:10.1016/j.janxdis.2014.05.010
McLellan, H. (1994). Virtual reality and multiple intelligences: Potentials for higher education. *Journal of Computing in Higher Education, 5*(2), 33-66. doi:10.1007/BF02948570
Medcalf-Davenport, N. A. (1998). Historical and Current Attitudes Toward and Uses of Educational Technology: A Work in Progress.
Merriam, S. B. (1998). *Qualitative Research and Case Study Applications in Education. Revised and Expanded from" Case Study Research in Education."*: ERIC.
Michaelsen, L. K., Knight, A. B., & Fink, L. D. (2004). Team-based learning: A transformative use of small groups in college teaching.
Michener, W. K. J. P. c. b. (2015). Ten simple rules for creating a good data management plan. *11*(10).

Miles, M. B., & Huberman, A. M. (1994). *Qualitative data analysis: An expanded sourcebook*: sage.
Miranda, H. P., & Russell, M. (2012). Understanding factors associated with teacher-directed student use of technology in elementary classrooms: A structural equation modeling approach. *British Journal of Educational Technology, 43*(4), 652-666. doi:10.1111/j.1467-8535.2011.01228.x
MOE. (2004). Notice About the Education Revitalization Action Plan in 2003-2007.
MOE. (2010). The Outline for National Mid-term and Long-term Educational Reform and Development Plan.
MOE. (2012). The Ten-Year Development Plan for Education Informatization (2011-2020).
MOE. (2016). Education Informatization Thirteen Five-Years Plan. [教育信息化"十三五"规划].
MOE. (2018). National Action Plan for the Revitalization of Teacher Education (2018-2022)
Moher, D., Liberati, A., Tetzlaff, J., Altman, D. G., & , P. G. (2009). Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. *6*(7), e1000097.
Moher, D., Liberati, A., Tetzlaff, J., Altman, D. G., & Group, P. (2009). Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. *PLoS med, 6*(7), e1000097.
Morgan, D. L. (2007). Paradigms lost and pragmatism regained: Methodological implications of combining qualitative and quantitative methods. *Journal of mixed methods research, 1*(1), 48-76.
Munn, Z., Peters, M. D., Stern, C., Tufanaru, C., McArthur, A., & Aromataris, E. (2018). Systematic review or scoping review? Guidance for authors when choosing between a systematic or scoping review approach. *BMC medical research methodology, 18*(1), 1-7.
Munn, Z., Porritt, K., Lockwood, C., Aromataris, E., & Pearson, A. (2014). Establishing confidence in the output of qualitative research synthesis: the ConQual approach. *BMC medical research methodology, 14*(1), 1-7.
Nan, G. (2002). Several Theoretical and Practical Issues about Education Informatization Part 1. [教育信息化建设的几个理论和实际问题(上)]. *Electronic Education Studies*(12), 20-24.
Newhouse, D. C. P. (2001). A follow-up study of students using portable computers at a secondary school. *British Journal of Educational Technology, 32*(2), 209-219. doi:10.1111/1467-8535.00191
Noyes, J. (2010). Never mind the qualitative feel the depth! The evolving role of qualitative research in Cochrane intervention reviews. *Journal of Research in Nursing, 15*(6), 525-534.
Okoli, C., & Schabram, K. (2010). A guide to conducting a systematic literature review of information systems research.
Onder, F., Celik, P., Silay, I., Karahoca, A., & Kanbul, S. (2011). Attitude of Teacher Candidates toward Making Computer Supported Education. *3*. doi:10.1016/j.procs.2010.12.158
Onwuegbuzie, A. J., & Johnson, R. B. (2006). The validity issue in mixed research. *Research in the Schools, 13*(1), 48-63.
Oral, B. (2008). The Evaluation of the Student Teachers' Attitudes toward Internet and Democracy. *Computers & Education, 50*(1), 437-445.
Orhan Goksun, D., Filiz, O., & Kurt, A. A. (2018). Student Teachers' Perceptions on Educational Technologies' Past, Present and Future. *Turkish Online Journal of Distance Education, 19*(1), 136-146.
Öst, L.-G., Brandberg, M., & Alm, T. (1997). One versus five sessions of exposure in the treatment of flying phobia. *Behaviour Research and Therapy, 35*(11), 987-996. doi:10.1016/S0005-7967(97)00077-6
Pantelidis, V. S. (1993). Virtual reality in the classroom. *Educational technology, 33*(4), 23-27.
Papert, S. (1993). *The children's machine: Rethinking school in the age of the computer*: ERIC.
Peters, M. D., Godfrey, C. M., Khalil, H., McInerney, P., Parker, D., & Soares, C. B. (2015). Guidance for conducting systematic scoping reviews. *JBI Evidence Implementation, 13*(3), 141-146.
Prasojo, L. D., Habibi, A., Mukminin, A., Muhaimin, Taridi, M., Ikhsan, & Saudagar, F. (2017). Managing Digital Learning Environments: Student Teachers' Perception on the Social Networking Services Use in Writing Courses in Teacher Education. *Turkish Online Journal of Educational Technology - TOJET, 16*(4), 42-55.
Protopsaltis, A., Goodwyn, A., & Fuller, C. L. (2009). *Outstanding teachers and ICT.* Paper presented at the Proceedings of the 27th ACM international conference on Design of communication.
Qiu, J. L., & Bu, W. (2013). China ICT studies: A review of the field, 1989–2012. *China Review, 13*(2), 123-152.
Qu, & Jiang. (2019). The Reform of Higher Normal Education in China over the Past 70 Years: Evolution, Achievements and Prospects [高等师范教育改革 70 年:演进、成就与展望]. *Educational Research*(8), 24-32.
Qu, C., Ling, Y., Heynderickx, I., Brinkman, W.-P., & Urgesi, C. (2015). Virtual Bystanders in a Language Lesson: Examining the Effect of Social Evaluation, Vicarious Experience, Cognitive Consistency and Praising on

Students' Beliefs, Self-Efficacy and Anxiety in a Virtual Reality Environment. *PLoS ONE, 10*(4). doi:10.1371/journal.pone.0125279

Redman, C., Trapani, F., & Australian Association for Research in, E. (2012). *Experiencing New Technology: Exploring Pre-Service Teachers' Perceptions and Reflections upon the Affordances of Social Media*.

Rehmat, A. P., & Bailey, J. M. (2014). Technology Integration in a Science Classroom: Preservice Teachers' Perceptions. *Journal of Science Education and Technology, 23*(6), 744-755.

Repetto, C., Colombo, B., & Riva, G. (2015). Is Motor Simulation Involved During Foreign Language Learning? A Virtual Reality Experiment. *SAGE Open, 5*(4). doi:10.1177/2158244015609964

Robson, C., & McCartan, K. (2016). *Real world research*: John Wiley & Sons.

Rousseau, D. M., Manning, J., & Denyer, D. (2008). Evidence in management and organizational science: Assembling the field's full weight of scientific knowledge through syntheses. The Academy of Management Annals, 2 (1): 475-515, 2008. *Marketing Letters, 21*, 6581.

Sabiescu, A., Van Zyl, I., Pucciarelli, M., Cantoni, L., Bytheway, A., Chigona, W., . . . Microsoft. (2013). Changing mindsets: The attitude of pre-service teachers on technology for teaching. *2 NOTES*, 136-139. doi:10.1145/2517899.2517927

Sancar-Tokmak, H., & Yanpar-Yelken, T. (2015). Effects of Creating Digital Stories on Foreign Language Education Pre-Service Teachers' TPACK Self-Confidence. *Educational Studies, 41*(4), 444-461.

Sayfouri, N. (2014). An Alternative Method of Literature Review: Systematic Review in English Language Teaching Research. *Procedia - Social and Behavioral Sciences, 98*(Supplement C), 1693-1697. doi:https://doi.org/10.1016/j.sbspro.2014.03.595

Scherer, R., Tondeur, J., Siddiq, F., & Baran, E. (2018). The importance of attitudes toward technology for pre-service teachers' technological, pedagogical, and content knowledge: Comparing structural equation modeling approaches. *Computers in Human Behavior, 80*, 67-80. doi:https://doi.org/10.1016/j.chb.2017.11.003

Schmidt, D. A., Baran, E., Thompson, A. D., Mishra, P., Koehler, M. J., & Shin, T. S. (2009). Technological pedagogical content knowledge (TPACK) the development and validation of an assessment instrument for preservice teachers. *Journal of Research on Technology in Education, 42*(2), 123-149.

Schön, D. A. (1983). *The reflective practitioner: How professionals think in action*: Routledge.

Schwienhorst, K. (1998). The 'third place' – virtual reality applications for second language learning. *ReCALL, 10*(1), 118-126. doi:10.1017/S095834400000433X

Selwyn, N. (1997). Students' attitudes toward computers: Validation of a computer attitude scale for 16–19 education. *Computers & Education, 28*(1), 35-41.

Shi, C., Wang, Z., & Li, Y. (2015). The Journey of Education Teechnology Localization: From Electronic Education to Education Informatization - Inspiration From Nan Guonong. [追踪欧洲教育技术前沿 助推中国教育信息化发展——访英国国家教育技术与标准中心高级研究员、博尔顿大学袁莉博士]. *Electronic Education Studies*(05), 26-32.

Singer, E. (2008). Ethical issues in surveys. *International handbook of survey methodology*, 78-96.

Smarkola, C. (2008). Efficacy of a planned behavior model: Beliefs that contribute to computer usage intentions of student teachers and experienced teachers. *Computers in Human Behavior, 24*(3), 1196-1215. doi:https://doi.org/10.1016/j.chb.2007.04.005

Spiegel, J. S. (2018). The ethics of virtual reality technology: social hazards and public policy recommendations. *Science and engineering ethics, 24*(5), 1537-1550.

Stone, A. R. (1996). *The war of desire and technology at the close of the mechanical age*: MIT press.

Sui, H., Wang, Y., Yang, R., Sun, Z., & Yang, Z. (2008). An Analysis of Education Informatization Trend in Higher Education. [国内外高校教育信息化发展趋势分析]. *The Chinese Journal of ICT in Education*(5), 4-6.

Tang, Xun, Mu, & Meng. (2001). Research into the Development Strategy of Teacher Education: Objectives, Countermeasures and Measures. [师范教育发展战略研究:目标,对策与措施]. *Teacher Education Research*(2), 6-15.

Tatar, E. (2013). The Effect of Dynamic Software on Prospective Mathematics Teachers' Perceptions Regarding Information and Communication Technology. *Australian Journal of Teacher Education, 38*(12).

Teclehaimanot, B., Mentzer, G., & Hickman, T. (2011). A Mixed Methods Comparison of Teacher Education Faculty Perceptions of the Integration of Technology into Their Courses and Student Feedback on Technology Proficiency. *Journal of Technology and Teacher Education, 19*(1), 5-21.

Teddlie, C., & Tashakkori, A. (2009). *Foundations of mixed methods research: Integrating quantitative and qualitative approaches in the social and behavioral sciences*: Sage.

Teo, T. (2008). Pre-Service Teachers' Attitudes towards Computer Use: A Singapore Survey. *Australasian Journal of Educational Technology, 24*(4), 413-424.
Teo, T. (2009). Modelling technology acceptance in education: A study of pre-service teachers. *Computers & Education, 52*(2), 302-312.
Teo, T. (2010). A Path Analysis of Pre-Service Teachers' Attitudes to Computer Use: Applying and Extending the Technology Acceptance Model in an Educational Context. *Interactive Learning Environments, 18*(1), 65-79.
Teo, T., Chai, C. S., Hung, D., & Lee, C. B. (2008). Beliefs about teaching and uses of technology among pre-service teachers. *Asia-Pacific Journal of Teacher Education, 36*(2), 163-174.
Teo, T., Lee, C. B., & Chai, C. S. (2008). Understanding pre-service teachers' computer attitudes: applying and extending the technology acceptance model. *Journal of Computer Assisted Learning, 24*(2), 128-143.
Thomas, J., O'Mara-Eves, A., Harden, A., & Newman, M. (2017). Synthesis methods for combining and configuring textual or mixed methods data. In: Sage.
Tiba, C., Condy, J., Chigona, A., & Tunjera, N. (2015). Digital storytelling as a tool for teaching: Perceptions of pre-service teachers. *Td-the Journal for Transdisciplinary Research in Southern Africa, 11*(1), 82-97.
Tınmaz, H. (2004a). *An assessment of preservice teachers' technology perception in relation to their subject area.*
Tınmaz, H. (2004b). An assessment of preservice teachers' technology perception in relation to their subject area. *Unpublished master's thesis, METU, Ankara, Turkey*.
Topkaya, E. Z. (2010). Pre-Service English Language Teachers' Perceptions of Computer Self-Efficacy and General Self-Efficacy. *Turkish Online Journal of Educational Technology - TOJET, 9*(1), 143-156.
Tort-Moloney, D. (1997). Teacher Autonomy: A Vygotskian Theoretical Framework. CLCS Occasional Paper No. 48.
Tricco, A. C., Antony, J., Zarin, W., Strifler, L., Ghassemi, M., Ivory, J., . . . Straus, S. E. (2015). A scoping review of rapid review methods. *BMC Med, 13*, 224. doi:10.1186/s12916-015-0465-6
Tsai, C.-C., & Chai, C. S. (2012). The" third"-order barrier for technology-integration instruction: Implications for teacher education. *Australasian Journal of Educational Technology, 28*(6).
Tsai, C.-C., Lin, S. S., & Tsai, M.-J. (2001). Developing an Internet attitude scale for high school students. *Computers & Education, 37*(1), 41-51.
Twinn, S. (1997). An exploratory study examining the influence of translation on the validity and reliability of qualitative data in nursing research. *Journal of advanced nursing, 26*(2), 418-423.
Varol, Y. K. (2015). Predictive Power of Prospective Physical Education Teachers' Attitudes towards Educational Technologies for Their Technological Pedagogical Content Knowledge. *International Journal of Progressive Education, 11*(3), 7-19.
Waddell, D. (2012). Point/Counterpoint: To flip or not to flip. *Learning & Leading in Techonolgy, 39*, 7-8.
Wang. (2019). New Normal Education System Outline in China. [我国新师范教育体系论纲]. *Journal of Northeast University (Philosophy and Social Sciences), 000*(005), 10-16.
Wang, L., Ertmer, P. A., & Newby, T. J. (2004). Increasing preservice teachers' self-efficacy beliefs for technology integration. *Journal of Research on Technology in Education, 36*(3), 231-250.
Wilkinson, M. D., Dumontier, M., Aalbersberg, I. J., Appleton, G., Axton, M., Baak, A., ... & Mons, B. (2016). The FAIR Guiding Principles for scientific data management and stewardship. *Scientific data*, *3*(1), 1-9.
Xiaoluo, J., Chang, L., & Lizhi, C. (2010). Implementation of a project-based 3D virtual learning environment for English language learning. In (Vol. 3, pp. V3-281-V283-284).
Yağci, M. (2016). Effect of information technologies (It) pre-service teachers' learning approaches on their attitude towards programing. *Turkish Online Journal of Educational Technology, 2016*(NovemberSpecialIssue), 794-802.
Yagci, M., Sirakaya, D. A., Ozudogru, G., Iaman, A., & Eskicumali, A. (2015). The investigation of attitude and readiness of information and communication technologies pre-service teachers toward web based learning. *174*, 1099-1106. doi:10.1016/j.sbspro.2015.01.800
Yang, J. C., Chen, C. H., & Chang Jeng, M. (2010). Integrating video-capture virtual reality technology into a physically interactive learning environment for English learning. *Computers & Education, 55*(3), 1346-1356. doi:10.1016/j.compedu.2010.06.005
Yapici, I. U., Hevedanli, M., Isman, A., Liu, E. Z. F., & Kiyici, M. (2012). Pre-Service Biology Teachers' Attitudes towards ICT Using In Biology Teaching. *64*, 633-638. doi:10.1016/j.sbspro.2012.11.074
Yavuz, S. (2005). Developing a Technology Attitude Scale for Pre-Service Chemistry Teachers. *Turkish Online Journal of Educational Technology-TOJET, 4*(1), 17-25.

Yeung, A. S., Lim, K. M., Tay, E. G., Lam-Chiang, A. C., & Hui, C. (2012). Relating Use of Digital Technology by Pre-Service Teachers to Confidence: A Singapore Survey. *Australasian Journal of Educational Technology, 28*(8), 1317-1332.

Yin, R. K. (2003). Case study research: design and methods (ed.). *Applied social research methods series, 5*.

Yucel, A. S., Kocak, C., Uzunboylu, H., & Cavus, N. (2009). Determination of attitudes of students teachers towards the utilization of technology: creating a technology tree. *1*(1), 2032-2037. doi:10.1016/j.sbspro.2009.01.357

Yuksel, G., Kavanoz, S., Karahoca, A., & Kanbul, S. (2011). In Search of Pre-Service EFL Certificate Teachers' Attitudes towards Technology. *3*. doi:10.1016/j.procs.2010.12.111

Zambak, V. S., & Tyminski, A. M. (2017). A Case Study on Specialised Content Knowledge Development with Dynamic Geometry Software: The Analysis of Influential Factors and Technology Beliefs of Three Pre-Service Middle Grades Mathematics Teachers. *Mathematics Teacher Education and Development, 19*(1), 82-106.

Zhang, B. (2009). Electronic Education Development History Chronology Addendum. [中国电化教育发展史拾零]. *e-Education Research*(1), 114-120.

Zhao, Luo, & Zhao. (2020). A Further Normalized Teacher Education： Normal Universities' Transformation and Value-Reshaping. [论师范大学再师范化转型及价值重塑]. *Educational Research, 041*(003), 143-151.

Zhao, H., & Ma, H. (2012). The Construction and Analysis of Chronology of China's Policies and Regulations on Education Informatization. [我国教育信息化政策法规年表构建与分析]. *Modern Distance Education Research*(5), 23-30.

Zhao, J., & Xu, F. (2010). The state of ICT education in China: A literature review. *Frontiers of Education in China, 5*(1), 50-73.

Zhou. (2019). Teacher Education Changes for 40 Years: Developing Process, Experience and Challenges. [教师教育变革 40 年:历程、经验与挑战]. *Teacher Education Research, 31*(002), 1-7.

Zhou, Q., Zhao, Y., Hu, J., Liu, Y., & Xing, L. (2010). Pre-service chemistry teachers' attitude toward ICT in Xi'an. *Procedia - Social and Behavioral Sciences, 9*, 1407-1414. doi:https://doi.org/10.1016/j.sbspro.2010.12.342

Appendix I: Descriptions of Included Studies in Systematic Review

ID	Studies	Study Types	Research Methods	Research Aims	Research Questions
1	Y. Akbulut et al. (2011)	Journal	Quantitative	This study explored the views of pre-service teachers regarding the communication technologies (ICT) at Turkish education indicators of information and faculties.	What are the pre-service teachers' perceptions regarding the ICT integration level of their education faculties with regard to gender, department, family income, PC experience, having a PC at home, and frequency of ICT use for instructional purposes?
2	Alblaihed (2016)	Thesis	Mixed	The study aims to explore the Saudi Arabian science and mathematics preservice teachers' perceptions and practices related to the integration of technology in the primary school classrooms.	What is the relationship between the science and mathematics preservice teachers' perceptions, practices and experience with technology of the integration of technology in the classroom? How does the school setting, the university setting, and the partnership setting influence the pre-service teachers' perceptions and practices of the integration of technology in the classroom?
3	Alkan and Erdem (2010)	Journal	Quantitative	The aim of the present study is to determine the attitudes of student teachers towards educational technology and the effect of teaching applications on attitudes towards educational technology.	1. What are the types of attitudes towards educational technology in students' teachers (5th grade) who have received teaching applications? 2. What is the level of attitudes towards educational technology in student teachers (1st grade) who have not received the teaching application lesson yet? 3. Is there a difference in the attitudes of student teachers towards education technologies according to the type of the teaching program? 4. Is there a difference between the attitudes of student teachers who have received teaching application and the attitudes of the students who have not received the course on educational technology? 5. Do the attitude scores of student teachers towards educational technology differ according to gender?
4	Bansilal (2015)	Journal	Qualitative	This qualitative study was designed to identify the ways in which technology was used and to explore the nature of this use.	Unspecified
5	Baz (2016)	Journal	Mixed	The purpose of this study is to reveal the attitudes of Turkish EFL student teachers towards technology use in language learning and teaching.	What are the attitudes of Turkish EFL student teachers towards technology use in language learning and teaching?
6	Birkollu et al. (2017)	Journal	Quantitative	The present study aims to investigate attitudes of pre-service teachers towards technology based on various variables.	1. What is the level of pre-service teachers' attitudes towards technology in general? 2. Do pre-service teachers' attitudes towards technology differ with respect to their age, gender, department and class level?
7	S. Can (2016)	Journal	Quantitative	The purpose of the present study is to determine the attitudes of the pre-service teachers of physical education and sports towards education technologies, and to investigate the effects of variables (whether they attend daytime or evening classes, their gender, type of high schools they graduated from, the region where the university attended is located and grade level) on these attitudes.	Unspecified
8	Chisalita et al. (2012)	Proceedings	Quantitative	This study aims to identify student teachers' perceptions regarding to the access at ICT infrastructure, their attitude toward technology and the main difficulties they encounter when they use ICT at the faculty.	Unspecified

ID	Studies	Study Types	Research Methods	Research Aims	Research Questions
9	Delaney et al. (2014)	Proceedings	Qualitative	This paper presents research that sought to document and identify the thinking and pedagogical practices of pre-service teachers as they utilize technologies for learning and as reflective tools.	Unspecified
10	Dogan et al. (2011)	Proceedings	Quantitative	The specific aim of this paper is to investigate the mathematics trainee teachers' attitudes towards the use of materials and technology in mathematics education. It also aims to draw implications for pre-service (and in-service) teacher education.	Unspecified
11	Eyyam et al. (2010)	Journal	Quantitative	in this study the aim is to find out the perceptions of prospective teachers of English towards the use of instructional technology, such as computers, Over Head Projectors (OHP), data projectors, and CD players, etc. in class.	Unspecified
12	Gok and Erdogan (2010)	Journal	Qualitative	The study aims to analyse the perceptions of the students studying at Hacettepe University in the Department of Primary Education about technology through the metaphor analysis.	Unspecified
13	Gurcay et al. (2013)	Journal	Quantitative	This study aims to explore the pedagogical beliefs of pre-service physics teachers from two cultures and seeks to examine the relationship between teachers' beliefs about constructivist and TT as well as the relationship between their beliefs about teaching and their beliefs about the use of technology.	1. What are the Turkish and Singaporean pre-service physics teachers' pedagogical beliefs and their beliefs about the use of technology? 2. Are there significant differences between Turkish and Singaporean pre-service physics teachers with respect to pedagogical beliefs and their beliefs about the use of technology? 3. Is there a significant relationship between Turkish and Singaporean pre-service physics teachers with respect to their pedagogical beliefs and their beliefs about technology?
14	Gyamfi (2017)	Journal	Quantitative	This study employed the Technology Acceptance Model (TAM) to empirically investigate factors that influence Ghanaian pre-service teachers' attitudes towards Information and Communication Technology (ICT) usage.	Hypothesis 1. Leadership support has a significant effect on perceived ease of use of ICT by the pre-service teachers. Hypothesis 2. The degree to which ICT is perceived to be relevant to a pre-service teacher's future job has a positive effect on usefulness of the technology. Hypothesis 3. Perceived ease of use significant impact on pre-service teachers' perceived usefulness. Hypothesis 4. Perceived ease of use has positive influence pre-service teachers' attitude towards ICT usage. Hypothesis 5. Perceived usefulness has significant impact on pre-service teachers' attitudes towards ICT usage.
15	Hismanoglu (2012b)	Journal	Mixed	The impetus of this research is to explore the distance prospective EFL teachers' perceptions of ICT integration by utilizing a questionnaire consisting of questions that are somewhat related to the technology acceptance model (TAM) which was originated by Davis in 1986.	1. What obstructs your positive perceptions toward ICT integration? 2. Do you think that learning ICT use at a distance is a disadvantage? 3. What do you suggest to better learn how to integrate ICT?
16	Incik and Akay (2017)	Journal	Mixed	The aim of the current study is to analyze competence level of pre-service teachers about techno-pedagogical education, present the relation with their technological perception and determine their views about educational technologies.	1. What is the competency level of pre-service teachers about technopedagogical education? 2.What are technological perceptions of pre-service teachers?

ID	Studies	Study Types	Research Methods	Research Aims	Research Questions
					3.Do the competence levels and technological perceptions of pre-service teachers about technopedagogical education differ according to variables of gender, class level and program being taught? 4.Is there a relationship between competence level of pre-service teachers about technopedagogical education and their technological perceptions? 5.What are the views of pre-service teachers about contributions of educational technologies to education processes? 6.What are the suggestions of pre-service teachers for improving contributions of education technologies to education processes?
17	E. J. Jung and Rhodes (2004)	Thesis	Quantitative	The objective of this study was twofold. The first was to develop and test the conceptual model of technology disposition in a sample of teacher education students. The second was to investigate the extent to which teacher education students were disposed toward technology in terms of aggregate Technology Disposition Scale for Teacher Education Student (TDS-T) scores and on each of the two subscales of predisposition and competence, and to determine if variations in these technology dispositions were associated or could be predicted with teacher education student characteristics including age, gender, ethnicity, area of teaching certification (early childhood, elementary, middle level, and secondary level education), education level (freshman, sophomore, junior, and senior), status of teacher education program admittance, and college GPA.	1.What are the factor structures of the Preservice Teacher Technology Survey (PTTS), and how reliable and valid is a new construct instrument. Technology Disposition Scale for Teacher Education Students (TDS-T)? 2.What is technology disposition of teacher education students as measured by aggregated scores of Technology Disposition Scale (TDS-T) comprised of technology predisposition and self-reported technology competence, and are there differences based on teacher education students' characteristics? 3.What is technology predisposition, as measured by aggregated scores of Factors 1 through 4 of the TDS-T, and are there differences based on teacher education students' characteristics? 4.How do teacher education students report themselves on self-reported technology competence of the TDS-T, and do their reports vary according to teacher education students' characteristics? 5.What variables significantly predict the differences in technology disposition, technology predisposition, and technology competence of teacher education students?
18	Karr and Steckelberg (2014)	Thesis	Quantitative	The purpose of this cross-sectional survey study was to identify the attitudes and beliefs student teachers have towards technology use in education and identify the perceived skills students possess at teacher preparation institutions from one midwestern state.	1.What is the student teachers' technology disposition toward technology integration? 2.How are the factors of technology ownership associated with students' technology disposition? 3.Does gender play a role in technology disposition toward technology integration for student teachers? 4.Does perceived technology competence relate to technology disposition? 5.Does technology disposition differ across the certification categories?
19	Kobak and Taskin (2012)	Journal	Mixed	Within this context, this study aims to determine prospective teacher's perceptions in terms of using technology supported with visual and metaphorical images.	1.What are the prospective teachers' perceptions in terms of using technology? a) Is there any significant difference in prospective gender? b) Is there any significant difference in prospective teachers' perceptions of using technology in terms of undergraduate program? 2.Which technology represents the concept of using technology in education the most according to prospective teachers? 3.Which metaphors represent prospective teachers' technology concept?

ID	Studies	Study Types	Research Methods	Research Aims	Research Questions
20	Koc and Bakir (2010)	Journal	Mixed	The purpose of this research is to find out pre-service teachers? background knowledge, experiences and perceptions about their preparation for technology integration at a university in the Middle East USA.	Unspecified
21	Orhan Goksun et al. (2018)	Journal	Qualitative	The aim of this study is to reveal Computer Education and Instructional Technologies student teachers', who are in a distance teacher education program, perceptions on past, present and educational technologies of future via infographics.	Unspecified
22	Yağci (2016)	Journal	Quantitative	The present study aims to investigate thinking styles of preservice teachers from the CEIT department and their attitudes toward the ICT and the relationship between these two variables.	1. What are the thinking styles of preservice teachers from the CEIT department? 2. Is there a relationship between thinking styles of preservice teachers from the CEIT department and their demographic characteristics (gender, grade level, academic success level)? 3. What is the attitude of the preservice teachers from the CEIT department toward Information Technologies? 4. Do attitudes of the preservice teachers from the CEIT department toward the Information Technologies vary according to variable of gender, grade level and academic success level? 5. Do attitudes of the preservice teachers from the CEIT department toward the Information and Communication Technologies display significant difference with respect to their thinking styles?
23	Yapici et al. (2012)	Journal	Quantitative	The aim of this study is to determine the pre-service biology teachers' attitudes towards ICT using in biology teaching in terms of various variables.	Unspecified
24	Yuksel et al. (2011)	Journal	Quantitative	The aim of this study is to examine the profile of a sample of pre-service TEFL Certificate teachers in Turkey.	1.What is the overall profile of pre-service teachers' attitudes towards technology? 2.Does technology attitude differ by gender, university type and subject domain?
25	Q. Zhou et al. (2010)	Journal	Quantitative	The purpose of this study is to investigate pre-service chemistry teachers' ICT attitude considering computer competence, computer attributes, culture perception as independent variables.	1. What are the attitudes of middle school pre-service chemistry teachers toward ICT in education? 2. What are the pre-service teachers? perceptions of their level of ICT competence? 3. What are the pre-service teachers? perceptions of ICT attributes? 4. What are the pre-service teachers? perceptions of cultural relevance of computer? 5. What are the independent variables and the proportion of the facts in the attitudes of teachers toward ICT in education?

Table 28. General Descriptions of Included Studies

ID	Studies	Settings	Subjects	Regions	Sample Size (n=)	Sampling Strategy	Ethical Considerations	Instruments	Data Analysis
1	Y. Akbulut et al. (2011)	Unspecified	Unspecified	Turkey	2515, 2627	combination of stratified random sampling and systematic sampling	Partially*	A personal information form and 75 items survey from Akbulut (2009), α=.96	Exploratory and confirmatory factor analyses
2	Alblaihed (2016)	primary school	science and mathematics	Saudi Arabia	Survey: 53 Interview: 7	non-probability sampling strategy	Yes	Modified TPACK questionnaire (Koehler, 2011), semi-structured classroom observations, and semi-structured interviews. Pre-service teachers who use technology, pre-service teachers who do not use technology to collect both quantitative and qualitative data	The questionnaire data were analyzed descriptively and inferentially. thematic analysis was used for qualitative data.
3	Alkan and Erdem (2010)	Unspecified	Biology, Physics, Chemistry and Mathematics	Turkey	244	Unspecified	Unspecified	"Attitude Scale towards Educational Technology" developed by Pala (2006). Cronbach Alpha reliability coefficient was 0.92.	Descriptive analysis, variance analysis, independent sample t-test
4	Bansilal (2015)	Unspecified	Mathematics	South Africa	52	Unspecified	Partially	written responses to a questionnaire and semi-structured interview 1. How have you used technology in your teaching practice? 2. How have you used technology in your own learning of maths? 3. What are some ways in which the availability of technology benefited or negatively affected the way you teach Maths? 4. What are some ways in which the availability of technology benefited or negatively affected the way you learn Maths?	Content analysis
5	Baz (2016)	Unspecified	English	Turkey	98	Convenience sampling	Yes	the scale of attitude towards technology by Yavuz (2005). The Crombach's alpha of the	The descriptive statistics, namely frequency and percentage, was used to analyze the attitude scale. Interpretive

ID	Studies	Settings	Subjects	Regions	Sample Size (n=)	Sampling Strategy	Ethical Considerations	Instruments	Data Analysis
								instrument is 0.8668. Focus group interview: 'What are your opinions and attitudes towards the use of technology in English language learning and teaching?'	approach was used to analyze the data obtained from the focus group interview. Content analysis was used in order to analyze the written transcriptions
6	Birkollu et al. (2017)	Unspecified	Psychology, Education, Computer Science	Cyprus	132	simple random sampling	Partially	Demographic information and Technology towards Attitude Scale (Yavuz, 2005)	Significance level was considered as $p < .05$ in statistical analysis. Percentage, frequency, test, ANOVA, Mann-Whitney U tests were used in data analysis.
7	S. Can (2016)	Unspecified	physical education and sports	Turkey	5120	Unspecified	Yes	Demographic features of the students and a 43-item Questionnaire of Attitudes towards Education Technologies developed by Pala (2006). Cronbach's Alpha coefficient 0.877	T-test was employed to test whether the attitudes significantly vary depending on whether the students attend daytime or evening classes and their gender was tested with t-test; and whether the attitudes vary significantly depending on the type of high schools they graduated from, the region where the university attended is located and the grade level was tested through One-Way ANOVA.
8	Chisalita et al. (2012)	Preschool and Primary School	Unspecified	Romania	120	Unspecified	Unspecified	The ICT attitude of student teachers'	Unspecified**
9	Delaney et al. (2014)	primary and secondary school	Science	Australia	220	Unspecified	Unspecified	The survey aimed to focus on their use and reactions to the new technologies and what the properties could be perceived to offer them, as both learners and teachers. Q1 What are your favourite Educational Apps - for use when teaching - and why? Q2. What is your vision for using technologies in the classroom? Q3. How have your goals for effective science teaching been supported by new technologies? Q4. How do you think your goals for personal learning	The survey responses were coded and analysed using Positioning Theory, which values and assists documentation, through discourse analysis, of the perceptions and relationships people have of/to events, objects and artifacts. The responses have also been referenced against Bloom's Revised Taxonomy to determine their existing perceptions and approaches for using technology.

ID	Studies	Settings	Subjects	Regions	Sample Size (n=)	Sampling Strategy	Ethical Considerations	Instruments	Data Analysis
								might be supported by technology?	
10	Dogan et al. (2011)	primary	mathematics	Turkey	125	Unspecified	Unspecified	self-developed questionnaire as a survey. The instrument comprises of three parts. First part is consisted a list of twenty six available groups of materials and technology. The second part is a Likert Type Attitude Scale. The third part of the questionnaire has a single open-ended question about the trainee teachers' views on the use of materials and technology in mathematics. α = 0.84	Descriptive analyses included percentages, means, standard deviations and frequency distributions.
11	Eyyam et al. (2010)	Unspecified	English	North Cyprus	47	Unspecified	Unspecified	The scale was designed and prepared by the researchers. There were two sections in the scale. The first section consisted of some demographic information about the participants. In the second part of the scale, there were 47 items and the participants were asked to rate them as a) Strongly Agree b) Agree c) Neutral d) Disagree e) Strongly Disagree. The items were categorized as i) the effects of technology use on the success of the students; ii) the effects of technology use on learning; iii) the effects of technology use on students? attention and motivation; iv) the effects of technology use on lessons; v) the effects of technology use on instructors? performance;	As the items in the scale were categorized into six different groups, the items for each group were analyzed together and the differences or the similarities between groups were presented in different tables.

ID	Studies	Settings	Subjects	Regions	Sample Size (n=)	Sampling Strategy	Ethical Considerations	Instruments	Data Analysis
								and vi) the effects of technology itself.	
12	Gok and Erdogan (2010)	Primary	Unspecified	Turkey	487	convenience sampling	Unspecified	Metaphors were used in collecting qualitative data in this study. First part of the form includes personal information related to various variables and the second part includes the completion of the sentence "Technology is like .. because .."	In the analysis of qualitative data, the perceptions of the pre-service teachers were analysed through the content analysis. Besides, in the analysis of quantitative data, the metaphors developed by pre-service teachers were analysed with appropriate statistical methods to find out whether it differentiates with various variables.
13	Gurcay et al. (2013)	secondary	physics	Turkey, Singapore	205	convenience sampling	Yes	The study employed two sets of survey instruments: the Teaching and Learning Conceptions Questionnaire (Chan and Elliott 2004) and the Use of Technology Questionnaire (Teo et al. 2008).	For the construct validity, exploratory factor analysis with principal component extraction was performed to establish four factor structures of the instruments. In the second step, confirmatory factor analysis (CFA) was performed to investigate construct validity of the instruments. Descriptive statistics related to the beliefs about teaching and use of technology and independent samples t test provide the answers for research question 1 and 2. To answer research question 3, we determine the relation between pedagogical beliefs and the use of technology beliefs through Pearson correlation.
14	Gyamfi (2017)	Unspecified	Unspecified	Ghana	380	random sampling	Yes	Apart from the demographic profile, the respondents responded to 17 statements on job relevance (JR) (3 items), leadership support (LS) (2 items), perceived usefulness (PU) (4 items), perceived ease of use (PEU) (4 items) and attitude towards use (ATU) (4 items).	descriptive and inferential analyses, exploratory factor analysis, multiple regression analysis
15	Hismanoglu (2012b)	primary and secondary	English	Turkey	85	Unspecified	Partially	A questionnaire was developed by the researchers to gather data about the perceptions of prospective EFL teachers in distance	Descriptive statistics were utilized to run for frequencies, percentages, mean and standard deviation

ID	Studies	Settings	Subjects	Regions	Sample Size (n=)	Sampling Strategy	Ethical Considerations	Instruments	Data Analysis
								higher education toward ICT integration. The questionnaire consisted of two parts. The first part asked about personal information such as gender, age and year of education to ensure maximum control of variables. The questions that we posed in the interview were as follows: 1. What obstructs your positive perceptions toward ICT integration? 2. Do you think that learning ICT use at a distance is a disadvantage? 3. What do you suggest to better learn how to integrate ICT?	
16	Incik and Akay (2017)	Mixed	Mixed	Turkey	626, 67	Unspecified	Unspecified	Techno-pedagogical Education Competency (TPACK-Deep) Scale, Kabakci Yurdakul et al. (2012). Technology Perception Scale, which was developed by Tinmaz (2004). There are two open-ended questions in the form which was developed by the researchers. These were; "Explain the effect of instructional technology on your education throughout Faculty of Education" and "What are your suggestions to improve contributions of instructional technologies to the education of pre-service teachers?"	Demographic variables were interpreted with frequency (f) and percentage (%) methods which are of descriptive statistics. Competency level of pre- service teachers about techno-pedagogical education and technological perception were interpreted through mean (M), standard deviation (SD), minimum (min) and maximum (max) scores. t-test was used to determine the relationship between gender and class of pre-service teachers and techno-pedagogical competence level and their technological perception; one-way analysis of variance (ANOVA) was used to determine whether it differs according to department. Pearson correlation analysis was done to determine the level of relationship between competence level of pre-service teachers about techno-pedagogical education and their technological perception. Data obtained from open-ended question form was analyzed in four stages which are

ID	Studies	Settings	Subjects	Regions	Sample Size (n=)	Sampling Strategy	Ethical Considerations	Instruments	Data Analysis
									(1) codification of data, (2) finding themes, (3) arrangement of codes and themes and (4) identification and interpretation of findings
17	E. J. Jung and Rhodes (2004)	Mixed	Unspecified	USA	656	purposive sample	Yes	Preservice Teacher Technology Survey (PTTS), a 30-item instrument. The PTTS was a combination of the selected or modified items from two different instruments adapted from Technology Survey for All Education Students (Medcalf Davenport, 1998) and Attitude toward Computer Technologies (Deicourt & Kinzie, 1993), and researcher-developed items.	The statistical analyses included descriptive statistics including means, medians, modes, percentages and frequency rates, factor analysis to identify the related variables for the factors, Pearson product-moment correlation analysis and analysis of variance (ANOVA) to examine the similarities and differences of data and their relationships, multiple regression analysis to identify the effects of the variables and significant predictors. Cronbach's Alpha and Spearman-Brown corrected correlation were calculated to measure the reliabilities. After initial item analysis for content validity, item analysis using correlation was also conducted to assess convergent validity and discriminant validity of the construct scale.
18	Karr and Steckelberg (2014)	Secondary	Unspecified	USA	476	convenience sampling	Yes	Technology Disposition Scale for Teacher Education Students (TDS-T) (Jung, Rhodes, & Vogt, 2006). The first section seeks demographic information related to gender, technology owned, and certification endorsement area. The second section will measure the students' technology attitudes and beliefs, or technology disposition. The final section asks students to rate their perceived skills and competence in relation to technology to determine their technology competency.	Descriptive statistics was first used to describe the data collected to answer research question 1. In order to answer research questions 2, 3, 4, and 5 inferential statistics were used. A two-way ANOVA was used to determine whether there were differences between genders on technology disposition, H1. To answer H2 and H3 Pearson correlations were used to determine if a relationship existed between the technology disposition and perceived technology competence or technology ownership. To determine if differences existed in technology disposition across the certification areas a one-way ANOVA was used, answering H4.

ID	Studies	Settings	Subjects	Regions	Sample Size (n=)	Sampling Strategy	Ethical Considerations	Instruments	Data Analysis
19	Kobak and Taskin (2012)	Secondary	science and mathematics	Turkey	104	Unspecified	Unspecified	Technology Perception Scale, Tinmaz (2004) Visual Association Activity: there are 11 images to be listed in order of importance. Metaphors: "Technology is like .... , because .... "	The statistical analyses of the quantitative data collected are done via SPSS 17 package program in the .05 significance level. The metaphors which are the qualitative data in this study are analyzed through content analysis method. In this method, categories are organized by clearing up the reasons for that metaphor.
20	Koc and Bakir (2010)	Mixed	Mixed	USA	26	Unspecified	Unspecified	In the first part, participants were asked to provide demographic information (e.g. gender, major, etc.) and background information on their technology experience including how long they have been using technology to enhance their personal and academic productivity, whether they have received any training about the use of technology, and what prior experiences they have with integrating technology into teaching. This section also asked their opinions about the role of technology in teaching and learning and barriers to technology implementation. These questions were mostly open-ended; therefore, allowed participants to explicitly express what they thought about such issues. Second part of the questionnaire were related to perceptions and beliefs about participants? knowledge and preparation to various aspects of using available technology for course planning, teaching, assessment, and	descriptive statistics such as frequency, percentage, mean and standard deviation were calculated to summarize the data. Open-ended items were coded to identify key patterns and themes emerged from the responses. Where appropriate, verbatim quotations from participants? written comments were reported in order to complement and support the quantitative findings by providing contextual-based and more-detailed information. The results were tabulated in the order of mean scores from highest to lowest to identify the salient issues.

ID	Studies	Settings	Subjects	Regions	Sample Size (n=)	Sampling Strategy	Ethical Considerations	Instruments	Data Analysis
								communication. The final part of the survey was designed to assess participants? current level of knowledge and skills for using a variety of technological applications.	
21	Orhan Goksun et al. (2018)	Unspecified	Unspecified	Turkey	65	convenience sampling	Yes	it is decided by researchers that infographics were employed to reveal student teachers' perceptions on a concept for this study. In this situation, the created written and visual materials were needed to be examined. Started from these points of view, it was decided that the best fit model for this study was document review.	When analyzing the documents, deductive analysis was conducted. During deductive analysis processes, the data are analyzed according to an existing frame- work. The main themes of analysis were determined as "The educational technologies of past", "The educational technologies of present" and "The educational technologies of future", and the frequencies of codes, which were situated under these themes, were examined. After the examination of frequencies of codes, it was tried to interpret what the codes express under which theme by the researchers. The documents of this research are infographics created by student teachers. The document in other words the data source was infographics because the main purpose was "revealing the perceptions of student teachers on the educational technologies of past, present and future" and the visuals are useful to reveal individual perceptions on a concept.
22	Yağci (2016)	Unspecified	Sciences	Turkey	186	Unspecified	Unspecified	Thinking Styles Scale, Turkish by Subu (2004) Attitude Scale toward the ICT, Cavas et al. (2009)	In determination of thinking styles of preservice teachers and their attitudes toward the ICT, descriptive statistics of frequency (f), percentage (%), average (X) and standard deviation (Sd) values were used. In order to evaluate the relationship between demographic characteristics (gender, grade level, academic success level), thinking styles and attitude of preservice teachers toward the ICT, t-test, one-way Anova test and Kruskal Wallis tests were utilized. In order to determine

ID	Studies	Settings	Subjects	Regions	Sample Size (n=)	Sampling Strategy	Ethical Considerations	Instruments	Data Analysis
									whether attitudes of preservice teachers toward the ICT displays difference with regard to their thinking styles, Pearson r correlation tests was utilized.
23	Yapici et al. (2012)	Unspecified	Biology	Turkey	70	Unspecified	Unspecified	Information and Communication Technology Attitudes Questionnaire-IAQ? (Kubiatko ve Halaova, 2009)	The analysis of the data were made by t test and ANOVA techniques. Significance level was taken to be .05.
24	Yuksel et al. (2011)	Unspecified	English	Turkey	200	Unspecified	Unspecified	The instrument included sections on participants' demographic background, gender, subject domain and university type, and the Attitudes to Technology (AT) questionnaire. The instrument is a twelve item 5-point Likert scale questionnaire that consists of two components of computer attitudes. The first component, 'Affect', is composed of seven items and measures feelings towards technology. The second component, 'Confidence' is composed of five items that measure the individual's confidence in using technology.	Data was analyzed using independent t-test.
25	Q. Zhou et al. (2010)	Unspecified	Chemistry	China	77	Combining with the methods of stratified sampling and random sampling	Unspecified	A matured scales (Albirini, 2006) including attitudes toward ICT, ICT competence scale, perceptions about the relative advantage of ICT, Cultural Perceptions scale	Unspecified**

*Partially Mentioned: Not stating consent form but mentioned volunteered participation.

**Unspecified Data Analysis: It can be inferred from the Result part in the original paper, but the authors didn't mention data analysis methods in the paper.

Table 29. Methodology Descriptions of Included Studies

ID	Studies	Findings	Implications
1	Y. Akbulut et al. (2011)	Perceptions differed with regard to different departments, gender and frequency of ICT use for instructional purposes whereas they did not vary with regard to income, PC experience, and having a PC at home. Teacher training programs did not facilitate the effective integration and use of ICTs for instructional purposes sufficiently.	Further research can administer similar data collection tools in different samples, investigate covariance errors among given ICT indicators in different contexts, and develop structural equation models to understand interrelationships among indicators. Such an approach can help scholars to determine priorities for action.
2	Alblaihed (2016)	All the pre-service teachers believed that technologies are regarded as an essential and important part of teaching and learning process nowadays. All of the five participants who used technology mentioned that the use of technology in the classroom could improve the pupils' learning and help in achieving the lessons' aims in a better way. Visualizing concepts through technology is the appropriate representation for the school level of primary school and the age range of the pupils. It can be argued that they used it because the required technology that suited their teaching strategies was available at school. In some cases, the participants already had a strong belief in the importance of technology and had previously planned to integrate it into their school placement teaching. there were several challenges reported by the pre-service teachers, including technical challenges, time challenges and personal challenges. School, university, and the partnership between them are important factors influencing their perceptions and practices related to the integration of technology in the classroom.	Therefore, improving teacher education programmes requires connecting them with the actual educational practices at schools where pedagogy and developing teachers' identity should be given the priority. Therefore, the whole structure of the partnership between university and school in Saudi Arabia needs to be reviewed in order to activate more collaborative work among all the stakeholders. Policy makers might need to consider this issue in the general strategic plans of education, giving more attention to the connection between teacher education programmes at universities and the actual situations in schools. Teacher educators should pay attention to providing pre-service teachers with pedagogical knowledge that allows them to recognise technology's affordances and to use these affordances to create an interactive learning environment where pupils take more control over their learning. Therefore, teacher education programmes need to consider preparing pre-service teachers to work collaboratively on wider social tasks, engage in the community and interact with others in order to be able to overcome the obstacles that might face them during teaching practice. Head teachers and cooperating teachers need to activate this step as crucial in the pre-service teachers' transition from theoretical study to practice. An ethnographic study and broader scope of the research could be conducted in the future.
3	Alkan and Erdem (2010)	The present study established that student teachers have a positive attitude towards educational technologies. It was observed that the attitude towards educational technologies does not differ according to department and gender. The attitudes of student teachers who received teaching application towards educational technologies were more positive than the student teachers who had not received teaching application.	Additional lessons should be added to the teaching program for educational technologies. Different educational technologies could be introduced for individual departments and examples can be given for the usage of them. Individuals concentrating on research, become acquainted with many technologies and gain a competency in choosing the most convenient and appropriate one. The faculties of education need to follow the developments and changes in educational technologies in line with their student profile and an appropriate updating can be realized. Technology competencies can be developed via educational technologies should be further researched.
4	Bansilal (2015)	Access to technology has made their tasks of learning and teaching much easier; they have a greater variety of strategies available; the technology allows them to vary the pace at which they can study; it has given them access to many different resources; it has granted them more independence in learning; and it has changed the nature of communication in which they engage, amongst other things. Some benefits of mathematics software were found to be the provision of different representations, dynamic visualization of concepts and variation in mathematical situations. It was also found that students used technology more often in their own learning than in their teaching, because the schools did not have many resources.	It is crucial that sufficient access to technical support must be provided in any rollout of technological resources to help teachers and learners use the technology more effectively. It is recommended that the education department prioritise the provision of specialist mathematics software that can be used to improve learning outcomes in mathematics.
5	Baz (2016)	It can be deduced from the findings that Turkish EFL student teachers in this study have positive attitudes towards the use of technology in language learning and teaching process. The student teachers in this study believe in the importance of technology in language learning and teaching and find it beneficial and seem to see technology inevitable for 21st-century learning and teaching contexts. Besides, it supports the notion	It seems crucial for these student teachers to have the knowledge of not only how to use technology especially with the new developments but also become aware of how to bring technology into their classrooms with the necessary equipment. Besides, there should be some precautions against the technology-related problems in the schools.

ID	Studies	Findings	Implications
		that feeling ready and competent in technology promotes the development of positive attitudes. Also, it can be said that they seem to use technology for their future career and feel anxious what to do if they do not have access to the technology in their future assigned schools. However, they also feel anxious about failing to keep up with the technological innovations because of the rapid development and high learner expectations. due to the fact that they have both positive attitudes towards the technology.	
6	Birkollu et al. (2017)	Results of the present study showed that attitudes of pre-service teachers towards technology are positive and significant differences were obtained between various variables and attitudes towards technology among pre-service teachers. It was revealed that attitudes towards technology significantly differ based on gender, attending a course before, department variable and their class level variable.	The number of lectures on technology might be increased in teacher training programs to increase knowledge and skills for pre-service teachers to use during their professional life. Seminars, courses studies experimental and with research conferences on technology might be organized for preservice teachers. Similar studies with qualitative or experimental research design might be carried out to provide a deeper understanding for what factors are associated with attitudes of pre-service teachers towards technology.
7	S. Can (2016)	The present study revealed that the general attitude of the students is in the category of "Agree" and hence, they have positive attitude. There is a significant relationship between the students' attitudes towards education technologies and whether they attended daytime or evening classes. The attitudes of daytime students are more positive than the attitudes of evening students. The study also revealed that the attitudes of the students of physical education and sports vary significantly depending on gender. This difference favors the female students as they exhibited more positive attitudes than the male students. There is a significant difference based on the type of the high schools they graduated from, and between the students' attitudes towards education technologies. There is a significant difference based on the region where the university attended is located, and the students' attitudes towards education technologies. No significant difference based on grade level was found among the students' attitudes towards education technologies, and the distribution of students among the grade levels are nearly even.	Conducting the research with the participation of students from different fields of the different faculties of different universities, can add different dimensions to the subject of the study. The researchers should attach greater importance to technology as there are continuous developments experienced in the field of technology, and they directly affect teaching and learning process and this increases the responsibilities of educators. More emphasis should be placed on courses that can impart information and skills to students from Schools of Physical Education and Sports and Faculties of Education so that they will be able to integrate technology and instruction and to use technological tools and equipments effectively and properly.
8	Chisalita et al. (2012)	The identified significant differences regarding the wireless internet and international databases access at the two faculties may suggest that students do not know about the existence of these two facilities in the faculty (still not) or do not know how to use them properly. Difficulties of he access to ICT resources encountered by students can be grouped into four main categories: problems related to hardware access (insufficient computers, old computers), difficulties related to ICT skills (lack of ICT skills), problems related to software equipment (different programs, internet connection) and problems related to time resources (not enough time to practice). Greater exposure to ICT resources of students from these generation may be the explanation of the difference observed between students of different age groups categories in terms of difficulties.	On the midterm this research will be extended to both first and third year of students from Pedagogy of Preschool and Primary School and on long term we envisage to involve also student teachers' for secondary schools.
9	Delaney et al. (2014)	Most respondents were able to provide a favorable vision for using technology, albeit on a personal level. The majority of respondents were unable to either describe an approach to incorporate technology in the classroom beyond rote/repetition uses, or describe an educational affordance of technology in their goals and visions statements.	There is still a need to incorporate challenging higher-order, collaborative tasks into our own in pre-service teacher education settings, to demonstrate to pre-service teachers that both the development of science understandings and the development of a community of learning in their students can be achieved by an informed selection of technology tools available.

ID	Studies	Findings	Implications
10	Dogan et al. (2011)	studying and teaching mathematics both for students and teachers. They appreciate possible enhancements to individual mathematics learning with the opportunities provided by the technology. Trainee teachers accept that materials and technology help to teach and learn mathematics better. Enjoyment, enthusiasm and self-confidence are very important affective factors in learning and teaching mathematics. Trainee teachers largely disagree with statements about the uselessness of materials and technology in mathematics.	Teachers need assistance in becoming more aware of how computers can be used to help their students meet a range of instructional objectives. These considerations can be supported by taking into account of Koehler and Mishra's (2008) TPACK theoretical framework to strengthen possible links and interactions between all main factors of pedagogy, technology and content knowledge.
11	Eyyam et al. (2010)	The results revealed that prospective English teachers at EMU have positive attitudes towards the use of instructional technology and they believe in the benefits of instructional technology. The results also revealed that the teachers? positive attitude towards the use of instructional technology will mostly help students to benefit more from the information they will be provided. Moreover, the results showed that this positive attitude will help teachers use more instructional technology tools and make learning more interesting and attractive for their prospective students.	As they will be proficient in using different kinds of technological devices, their lessons will be more fun and students will be able to benefit more from the lessons.
12	Gok and Erdogan (2010)	In the study, the pre-service teachers' perceptions related to technology is consisted of nine categories as "needed", "constantly changing", "developing", "harmful", "beneficial", "addictive", "both beneficial and harmful", "rapidly improving" and "facilitating our life". Pre-service teachers perceive technology mostly as "both beneficial and harmful" and "addictive" at the very least.	This finding of the study indicates that the perceptions of pre-service teachers about the technology vary and the perceptions about the technology are generally positive. In the light of the results of this study these recommendations can be given for teacher education and later studies: 1. Education settings should be developed for pre-service teachers to enable them develop positive perceptions towards technology. Thus, it is achieved that pre-service teachers use technology more actively in learning and teaching process. 2. Instructors should use technology effectively in classes and they should be a model for pre-service teachers to enable them develop positive perceptions towards technology. 3. Similar studies can be carried out with teachers to identify their perceptions related to technology. 4. Similar studies can be carried out with teachers in different fields and considering different variables.
13	Gurcay et al. (2013)	The results of this research indicate that both Turkish and Singaporean pre-service physics teachers are more inclined toward CT rather than TT. No statistical differences were detected between the Singaporean and Turkish pre-service physics teachers' pedagogical beliefs. However, a statistically significant difference was detected between Turkish and Singaporean pre-service physics teachers? Constructivist use of technology beliefs. ICT beliefs is positively correlated with constructivist use of technology, as expected. However, CT beliefs is also positively correlatedwith traditional use of technology.	Further qualitative research should be conducted to further understand the dynamics between beliefs and practice especially in terms of how contextual factors shape teachers' Instructional decision. It would be necessary to expose teachers to the use of ICT in a student-centered learning environment to improve their self-efficacy in CT.
14	Gyamfi (2017)	(1) leadership support significantly influenced perceived ease of use; (2) job relevance significantly influenced perceived usefulness; (3) perceived usefulness significantly influenced attitude towards use; (4) perceived ease of use significantly influenced attitude towards use (5) the TAM is significant for pre-service teacher education context except the relationship between perceived ease of use and perceived usefulness.	Given that pre service teachers' in the Colleges of Education would be acting as change agents for integrating ICT in the Ghanaian schools, knowing and understanding factors influencing these prospective teachers' attitudes towards ICT usage, would enable policy makers and curriculum designers better design teaching curriculum which can help enhance the use of ICT in teaching and learning among pre-service teachers and in-service teachers in future.
15	Hismanoglu (2012b)	this research study done in a distance higher education context unearthed negative teacher attitudes toward the use of ICT in language teaching. Lack of exposure to lessons fully designed with ICT tools, lack of opportunities to try ICT, the need to practice in a	Distance EFL teacher training programs should reevaluate their teaching methods and give importance to training specific to methodologies and practices of ICT integration, ICT-integrated sample lessons conducted in face-to-face classroom environments by

ID	Studies	Findings	Implications
		technology laboratory, lack of educational technology teachers, an exam-driven education system and studying to learn only what is to be tested were some of the underlying reasons for the prospective EFL teachers' negative perceptions of ICT use in the language learning or teaching process. The results of this study also apparently show that despite having basic computer skills, prospective EFL teachers in distance education were not confident in using the technology to improve their own productivity and bring about a pedagogical change in their teaching methods. Moreover, this research study reveals that prospective EFL teachers in distance higher education, despite having negative attitudes toward ICT integration and not utilizing it in the classroom, viewed ICT as a tool to help them to learn many things. Finally, it is obvious that unless teachers perceive the new technologies as valuable, they will be unwilling or unable to use them meaningfully.	educational technology specialists and providing computer laboratories in central cities of our country to increase prospective EFL teachers? self- efficacy and decrease their anxiety about using ICT skills.
16	Incik and Akay (2017)	It was concluded that pre-service teachers generally regard themselves at moderate level in the sense of technopedogogical education competency. Findings of the study show that pre-service teachers have positive perception towards technology. The findings of the current study show that pre-service teachers' competency level about technopedogogical education and their technological perception do not differ according to gender and department. The findings of this study show that pre-service teachers' technopedogogical educational competency and perception towards technology differ significantly on behalf of pre-service teachers who study at English Language Teaching Department. The findings of the current study show that there is a positively significant relationship between pre-service teachers' technopedogogical educational competency and perception towards technology. According to the results of qualitative analysis of the study, pre-service teachers think that educational technologies have contributions to preparing ICT-based presentations, developing technology-based materials, preparing homework, doing research, raising awareness about importance of educational technology use in the learning and teaching process, acquiring information about their department, developing personal skill of using technology based on information-communication technologies and having a positive attitude toward technology in general.	For Practitioners: Progress can be achieved about this issue when curriculum of Faculties of Education is enriched with optional courses that help or would enable pre-service teachers' use of technologies based on pedagogy and content knowledge. Different courses of teacher training fields can be implemented with technology (IT) assisted approach. In order to teach pre-service teachers how to integrate learning environments to technology, practice-oriented activities which include instructional design through technology should be arranged. It is important to teach courses in each branch about the execution of technology integration in curriculum of Faculties of Education and to give students instructions about how to integrate ICT according to subjects in the classroom. It must be paid particular attention in this process that academicians should integrate technology effectively during their courses and be good role models for prospective teachers. Computer laboratories should be open to the use of pre-service teachers apart from courses so that they can use these technologies more frequently. The number of students in classes should be reduced from 40-50s to 20s, laboratory and material deficiencies should be overcome, and special classrooms should be designed according to the quality of courses. Projects can be developed by which pre-service teachers can make peer-learning about current technologies and have information from each other. Technology consulting center can be founded in Faculties of Education in order to provide pre-service teachers with consulting service. For Researchers: It is thought that further research should be done in which different variables that are thought to be effective in perception about technology and technopedogogical education competency are involved and experimental designs are arranged about observation of learning-teaching processes. Mixed and longitudinal methods may be employed to examine the technological perceptions of the pre-service teachers. Comparative studies may be conducted between the countries which have better rankings in PISA assessments to identify the effectiveness of technology in teacher training.
17	E. J. Jung and Rhodes (2004)	Male students were significantly higher on the overall technology disposition scores than female students, but the differences were due to their strong self-concept, especially self-confidence, which was the subset of self-concepts. Students' technology competence level was significantly higher for seniors than for sophomores. The overall technology	Based upon the results of the analyses, it is recommended that the importance of technology should be stressed frequently and intensely. At the same time, teacher education students should be able to see the value of using technology and living with technology. With this in mind, it is very important for future teachers to learn the use

ID	Studies	Findings	Implications
		disposition scores significantly changed between their junior and senior years. No significant differences were found according to age, ethnicity, teaching level, teacher education program admittance status, and college GPA. The TDS-T demonstrated content validity through factor analysis, and convergent and discriminant validity through item analysis. Value for Cronbach' alpha was .93, indicating highly satisfactory reliability.	and integration of technology through the modeling of teacher educators.
18	Karr and Steckelberg (2014)	This study found the students attitudes and beliefs were positive toward technology integration. They were strongest in areas dealing with long-term beliefs: technology as in inevitable tool in the classroom, agreeing they will incorporate technology in the classroom, and using it to assist in organizing their work. The questions where they scored lowest dealt with self-confidence, or self-concept. It was also found that personal ownership of a number of different technologies correlated with technology disposition. It would seem that the more technology owned would lead to more confidence and likelihood an individual would use technology not only for personal use but also within their work. Student teachers that perceive themselves as competent in using technology had higher overall technology dispositions. Sense of competency comes from experiences and usage. Owning the technologies would give an opportunity for increase use, and ultimately skill. Students that own and use technology may have better attitudes toward its use in their classroom. Training to provide knowledge in how to use a variety of technologies, troubleshoot those technologies, and integrate them in the classroom is essential to their success with technology. Another area of interest, from the data, comes from student's self-reported competencies.	To include student teachers from around the United States may give a clearer picture as to the attitudes and beliefs all student teachers have toward technology integration. This could potentially better inform teacher education preparation institutions and school districts that provide continued professional development. Another question that this study raised for the researcher was if a longitudinal study could be done to follow candidate teachers from the time they enter the program, to their student teaching semester, and finally a year or two following their completion to see if their attitudes and beliefs change over time. Another suggestion would be to determine if attitudes and beliefs would change if teacher preparation programs provided technology to their candidate teachers. Of particular interest to this researcher, would be to include in-service teachers in the survey to determine if there is a difference in technology disposition among those teachers already practicing and those about to enter the profession. Additional research that would explore actual competencies, rather than perceived competencies, relationship to overall technology disposition would be informative.
19	Kobak and Taskin (2012)	it can be said that prospective teachers have positive perceptions concerning technology. There is no difference between prospective teachers in terms of gender in this study. no significant difference between prospective teachers in terms of undergraduate program. The results of visual association activity showed that the most show that prospective teachers ranked smart board, computer and internet in the first place and camera/ video, mobile phone which they commonly associate them with the technology using concept in education and portable media players (mp3/mp4) in the last place.	When teachers are constantly educated about the changing information technologies with pre and in service education for improving their abilities of using technology effectively, it helps increase their perceptions and facilitate the integration of technology in education. For this reason, in pre and in-service educations it is vital to give enough consideration in terms of using technology and raise teachers' awareness. Having adequate instruction during their education, prospective teachers can develop positive ideas in terms of instruction with technology and they can believe in the effectiveness of it. Therefore, instructors, facilitators have to use technology effectively in education faculties. Similar studies can be made on teachers to determine their perceptions in terms of using technology. Furthermore, prospective teachers' representations of technology concept can be taken into account and new studies can be made by considering their reasons.
20	Koc and Bakir (2010)	In this study, participants were neutral about their readiness to use technology in their teaching. Nevertheless, majority of the participants indicated that they need more training to learn how to implement computer technologies in order to enhance their students' learning. They also indicated that technology was frustrating to use when adequate support was not received. Another indicator of such a need for more training was the lack of knowledge that was the most frequently explained impeding factor in pre-service teachers? implementation of computer technology into teaching in their course work or early field experience. Moreover, pre-service teachers should be taught about the nature of technology and its alternative roles in educational contexts other than searching and	On the whole, teacher education programs should provide pre-service teachers with learner-centered, collaborative, authentic and inquiry-based learning environments in order to help them understand how to use technologies as tools to enhance their teaching and students` learning. Such environments should be in the way to enable them to (a) generate technology-integrated instructional projects and strategies to address their questions, problems, and issues related to technology integration, (b) implement and evaluate their products to investigate in what kind of situations technology is really working effectively, and finally (c) share their experiences and findings with their peers. Even these trainings can be web-based and accessible at distance so that pre-service teachers can make use of these based on their own interests, pace, and time.

ID	Studies	Findings	Implications
		presenting information and time-saving applications. The study indicated that pre-service teachers still use technologies within the objectivist model of teaching and learning.	
21	Orhan Goksun et al. (2018)	Participants considered “CD” (f=32) and “Television” (f=32) as educational technologies of past most frequently. Suggesting the most frequent views of educational technologies of present are “Online courses” (f=23) supported this idea. The most remarkable findings of study may be foresights of student teachers’ educational technologies of future. Student teachers dwelled on some technologies such as “Hologram” (f=26), “Virtual classroom” (f=22), “Real e-books” (f=18) and “Fiber plastic desks” (f=15). The most frequent views were created under educational technologies of past (f=241) and educational technologies of present (f=240) themes.	Teachers should be trained in the use of technologies and their integration into the teaching/learning process. At this point, it is suggested that current study is supported through action researches with student teachers and compare findings with this study.
22	Yağci (2016)	Preservice teachers from the CEIT department at most preferred innovative thinking style which likes to deal with indetermined indefinite works and which exhibits innovative and visionary characteristics. Thinking styles preferred by participants do not exhibit significant difference gender variable. Grade level variable, similarly, is not significantly different with respect to thinking styles preferred by participants. However, it was observed that average scores have changed at grade level even though it is at minor level. Attitude of preservice teachers from the CEIT department toward the ICT does not display significant difference according to their gender. Similarly, attitude of participants toward the ICT does not display significant difference according to their grade levels. However, grade level of participants is moderately effective on their attitude toward to usage of ICT in education. There is positive and proportional relationship between academic success levels of preservice teachers from the CEIT department and their attitude toward the effect of ICT on education and teaching. It was revealed that as innovative thinking style perception level increases; their attitude toward the ICT develops in the same way. On the contrary, while perception level regarding traditionalist thinking style increases, their attitude toward the ICT decreases.	1.Each individual adopts different thinking style. Education activities are required to be conducted by considering the fact that students do not adopt the same thinking style. Since the most frequently preferred thinking styles by students are extrovert and innovative thinking styles, it is suggested that more innovative and imaginative thinking styles which requires cooperation must be used in education process that will be applied to preservice teachers. 2. By considering that thinking is an individual process, first of all it is necessary to allow preservice teachers to raise their awareness regarding their thinking styles. To that end, new courses based on thinking education must be included in the curriculum. In the present study, thinking styles of preservice teachers, their attitude toward the ICT, and the prevailing relationship among them were investigated; and the scope of the research was limited with the registered students from the CEIT Department of the Educational Sciences Faculty at the Ahi Evran University. The present study can be developed further by means of more extensive studies including larger preservice teacher population from the CEIT Departments of other universities. 3. The relationship among attitudes of preservice teachers toward the ICT and learning approaches of individuals, material design sufficiency and techno-pedagogical sufficiency can be investigated.
23	Yapici et al. (2012)	The results indicate that; pre-service biology teachers have positive attitudes towards ICT using in biology teaching and although their attitudes do not differ regarding gender and class.	Increasing the number of applications to be carried out during pre-service teachers’ undergraduate education to develop their ICT use skills and their attitudes towards ICT could increase their attitudes as well. In this respect, web-aided applications could be increased. Prior to web-aided applications to be carried out at universities, determining students? ICT attitude levels could increase the effectiveness of such applications.
24	Yuksel et al. (2011)	Overall, the participants showed positive attitudes towards technology, as shown by the mean scores for the two subscales being 3.5 and above (on a 5-point scale). The overall positive level of attitudes could be attributed to the availability and accessibility to technological tools such as computers given to the pre-service teachers at various stages of their education. With respect to independent variables, we found significant differences in attitudes by gender.	Further studies are necessary for a systematic examination of all aspects of teacher education and how these interact to impact on pre-service teachers' attitudes and usage of the computer as a tool for instructional purposes and professional development.
25	Q. Zhou et al. (2010)	The findings of the study indicated a very strong positive correlation between teachers’ attitudes toward ICT in education and their perceptions of computer attributes. However, teachers’ perceptions of the complexity of ICT with their current teaching practices were not as positive. ICT competence was the second most important predictor of computer	Unspecified

ID	Studies	Findings	Implications
		attitudes in this study. The majority of respondents reported having little or no competence in handling most of the computer functions needed by educators. In addition, the relationship between computer attitudes and competence suggests that higher computer competence may foster the already positive attitudes of teachers and eventually result in their use of computers within the classroom. The majority of respondents regarded computers as pertinent to both Chinese schools and society and viable means for improving education and standards of living in general. What should not go unnoticed, however, is that the majority of the respondents felt that it is necessary to know how to use computer for their future jobs. In addition, many of the respondents saw that there are more important social issues to be addressed before implementing computers in education.	

Table 30. Outcome Descriptions of Included Studies

Appendix II: Pre-Service Teachers' Perceptions on Virtual Reality and ICT Training Needs Questionnaire

The purpose of this project is to provide a foundation for further professional development in ICT training of ESL/EFL teachers in China's universities by assessing pre-service teachers' virtual reality beliefs and their ICT training needs. Questions in the survey are divided into three sections, the background information, VR beliefs in language learning and teaching and the ICT training needs. Questions in the second and third sections are all Likert Scale Questions (LSQ) that 5 scales are available for the questions, i.e. Strongly Disagree, Disagree, Neutral, Agree, and Strongly Agree. Please indicate your standpoint of each statement.

SECTION 1: BACKGROUND INFORMATION

1. Year ____ Student
2. Gender: Male/Female
3. Age: ____
4. I have access to the following devices:
    a. Desktop Computer
    b. Laptop
    c. Mobile Phone
    d. Tablet/iPad
    e. Virtual Reality Headset
5. Do you believe that you will use any educational software or hardware in the teaching practice? Yes/No
6. If yes, please list 3 technologies you would like to use most
   1) _____; 2) _____; 3) _____;
7. Have you attended ICT training courses in the past? Yes/No
8. If YES, which institution organized or supervised these courses? _____
   And which units or topics were included your training courses? _____
9. Have you ever experienced virtual reality before? Yes/No

SECTION 2: VR BELIEFS IN LANGUAGE LEARNING AND TEACHING

[Openness to New ICT Tools]

1. I like being exposed to new advanced technologies, such as virtual reality.
2. I like learning with the use of new technologies, platforms and channels in my teaching.
3. I am aware of the recent development in virtual reality and its application in language teaching.
4. I look forward to using virtual reality equipment in my future teaching career.

[Perceived Usefulness]

5. I think the use of virtual reality in language learning is stimulating and interesting.
6. I think the use of virtual reality will make my teaching more stimulating and interesting.
7. I think the use of virtual reality will enhance my effectiveness in language teaching.
8. I think using virtual reality can assist me to teach students complex language structure.

[Perceived Ease of Use]

9. My teaching objectives with virtual reality will be clear and understandable.
10. I think virtual reality can accomplish the teaching objectives in the classroom.
11. I think virtual reality equipment is easy to use.
12. I think it would be easy to handle teaching sessions with virtual reality equipment.

[Technological Complexity]

13. Learning to use virtual reality equipment will take up too much of my time.
14. Using virtual reality equipment in the classroom will involve too much time in lesson planning.
15. I think it will be difficult for me to learn how to use virtual reality equipment in language teaching.

16. I think it will be hard for me to use virtual reality equipment so that it is aligned to my teaching objectives.

SECTION 3: ICT TRAINING NEEDS

[Attitudes to ICT and ICT Training]

1. I have the required ICT related skills.
2. I have the necessary ICT related skills.
3. I'm confident in using basic productivity tools.
4. I'm confident in using educational software provided by the university.
5. I'm interested in ICT using in classroom instruction.
6. I often incorporate the use of ICT in classroom instruction.
7. The contribution of educational software is significant in my professional development.
8. I believe that ICT training can have a positive effect on my professional development.

[Reasons for ICT Training]

9. ICT training is a significant component of my professional development.
10. I can take advantage of ICT to use it in course preparation and teaching issues.
11. I can take advantage of ICT to use it for my own personal purposes.
12. I will have the chance to communicate with and make acquaintance of other colleagues with ICT.
13. A certificate in ICT training will contribute significantly to my salary prospects.
14. I can have time off from the school environment when I attend training.
15. ICT training is deemed mandatory by the authorities of my training institution and by the Ministry of Education.
16. I will be reluctant to use ICT in the classroom after the ICT training because my students may know more than I do about using ICT.

[Expectations of ICT Training]

17. I would like to improve my ICT literacy through ICT training.
18. I would like to participate in introductory courses in Internet use and general applications.
19. I would like to participate in intermediate courses in using teaching tools for the classroom.
20. I would like to participate in advanced courses in the application of teaching tools for the classroom.
21. I would like to participate in courses on pedagogical issues related to integrating ICT into instruction and learning.
22. I would like to develop closer relationships with the colleagues through the ICT training program.

[Preference of ICT Training]

23. I prefer a short time for ICT training (2-4 hours).
24. I prefer a training program that lasts about a month.
25. I prefer a training program that lasts no more than 3 months.
26. I prefer a training program that continues over whole semester.
27. I prefer ICT training provided by other institutions rather than from the Ministry of Education, Lifelong Learning etc.
28. I'm willing to join ICT exchange training programs abroad.
29. I would prefer the government or the university to pay for my training.
30. I would be happy to pay any training fees myself.

Thank you for completing the questionnaire. If you have any additional comments or questions relating to this survey, please write them below:

_____

_____

Appendix III: Interview Questions

1. Have you ever experienced virtual reality technology and how do you think of that?

（你以前有没有体验过虚拟现实技术？感觉如何？）

2. What kind of virtual reality equipment do you prefer for personal use and classroom use?

（在个人使用和在课堂上使用时，你会分别选择使用什么样的虚拟现实设备？）

3. How do you see virtual reality technology as a teaching and learning environment?

（你对虚拟现实技术作为一种教学环境是怎样的看法？）

4. What aspects do you see virtual reality technology as a potential popular tool in teaching and learning?

（你觉得虚拟现实科技能在什么情况下能得到大众的认可并在教学当中普遍应用？）

5. How will you use virtual reality technology for English language teaching? / What do you expect from virtual reality for English language teaching in terms of the contents?

（你会怎么利用虚拟现实技术在课堂上进行英语教学？/ 你对虚拟现实在英语教学内容中有什么期待？）

6. What do you expect from virtual reality technology in order to complement your teaching practice?

（你对虚拟现实技术在教学当中的应用的展望是什么？）

7. Any aspects that will hamper you implementing virtual reality in the classroom?

（有什么因素会阻止你在课堂中使用虚拟现实技术吗？）

8. Do you think you need to be trained to use virtual reality in the classroom?

（你觉得老师使用虚拟现实设备之前是否要进行培训？）

9. If you need training for implementing virtual reality in the classroom, what kind of training do you want to receive?

（你觉得老师在虚拟现实教学方面需要接受什么样的培训？）

Appendix IV: Consent Form

Welcome and Consent

Researcher: Honghuan Li
Department: School of Education
Contact details: honghuan.li@durham.ac.uk

Project title: Pre-service Teachers' Perceptions of ICT and Virtual Reality

The purpose of this project is to provide a foundation for the exploration of pre-service English teachers' perception of VR technology and their training needs in China.

Questions in the survey are divided into three sections, the background information, VR beliefs in language learning and teaching and the ICT training needs. Questions in the second and third sections are all Likert Scale Questions (LSQ) that 5 scales are available for the questions, i.e., Strongly Disagree, Disagree, Neutral, Agree, and Strongly Agree.

Here, ICT means Information and Communication Technology. VR means Virtual Reality.

You may withdraw your consent to participation at any time during the project, without any repercussions to you, by contacting the researcher.

Before the questionnaire, you need to confirm that you understand what the purposes of the project, what is involved and that you are happy to take part.

1. I confirm that I have read and understand the information sheet and the privacy notice for the above project.

2. I have had sufficient time to consider the information and ask any questions I might have, and I am satisfied with the answers I have been given.

3. I understand who will have access to personal data, how the data will be stored, and what will happen to the data at the end of the project.

4. I agree to take part in the above project.

5. I understand that my participation is voluntary and that I am free to withdraw at any time without giving a reason.

6. I understand that anonymised (i.e. not identifiable) versions of my data may be archived and shared with others for legitimate research purposes.

7. I consent to completing the questionnaire on ICT training needs.

8. I consent to completing the observation form in the classroom.

9. I consent to experiencing Oculus Go Standalone VR Headset during the interview.

10. I consent to being audio recorded in the interview and understand how recordings will be used in research outputs.

11. I consent that my words may be quoted in publications, reports, and other research outputs anonymously.

Please indicate your agreement:

I have read all the statements and I agree to all the statements above.

Appendix V: Privacy Notice

PART 1 – GENERIC PRIVACY NOTICE

Durham University's responsibilities under data protection legislation include the duty to ensure that we provide individuals with information about how we process personal data. We do this in a number of ways, one of which is the publication of privacy notices. Our privacy notices comprise two parts – a generic part and a part tailored to the specific processing activity being undertaken.

Data Controller

The Data Controller is Durham University. If you would like more information about how the University uses your personal data, please see the University's Information Governance webpages or contact:

Information Governance Unit
Telephone: (0191 33) 46246 or 46103
E-mail: info.access@durham.ac.uk

Data Protection Officer

The Data Protection Officer is responsible for advising the University on compliance with Data Protection legislation and monitoring its performance against it. If you have any concerns regarding the way in which the University is processing your personal data, please contact the Data Protection Officer:

Jennifer Sewel

University Secretary

Telephone: (0191 33) 46144

E-mail: jennifer.sewel@durham.ac.uk

Retention

The University keeps personal data for as long as it is needed for the purpose for which it was originally collected. Most of these time periods are set out in the University Records Retention Schedule.

Your rights in relation to your personal data

Privacy notices and/or consent

You have the right to be provided with information about how and why we process your personal data. Where you have the choice to determine how your personal data will be used, we will ask you for consent. Where you do not have a choice (for example, where we have a legal obligation to process the personal data), we will provide you with a privacy notice. A privacy notice is a verbal or written statement that explains how we use personal data.

Whenever you give your consent for the processing of your personal data, you receive the right to withdraw that consent at any time. Where withdrawal of consent will have an impact on the services we are able to provide, this will be explained to you, so that you can determine whether it is the right decision for you.

Accessing your personal data

You have the right to be told whether we are processing your personal data and, if so, to be given a copy of it. This is known as the right of subject access. You can find out more about this right on the University's Subject Access Requests webpage.

Right to rectification

If you believe that personal data we hold about you is inaccurate, please contact us and we will investigate. You can also request that we complete any incomplete data.

Once we have determined what we are going to do, we will contact you to let you know.

Right to erasure

You can ask us to erase your personal data in any of the following circumstances:

- We no longer need the personal data for the purpose it was originally collected
- You withdraw your consent and there is no other legal basis for the processing
- You object to the processing and there are no overriding legitimate grounds for the processing
- The personal data have been unlawfully processed
- The personal data have to be erased for compliance with a legal obligation
- The personal data have been collected in relation to the offer of information society services (information society services are online services such as banking or social media sites).

Once we have determined whether we will erase the personal data, we will contact you to let you know.

Right to restriction of processing

You can ask us to restrict the processing of your personal data in the following circumstances:

- You believe that the data is inaccurate and you want us to restrict processing until we determine whether it is indeed inaccurate
- The processing is unlawful and you want us to restrict processing rather than erase it
- We no longer need the data for the purpose we originally collected it but you need it in order to establish, exercise or defend a legal claim and
- You have objected to the processing and you want us to restrict processing until we determine whether our legitimate interests in processing the data override your objection.

Once we have determined how we propose to restrict processing of the data, we will contact you to discuss and, where possible, agree this with you.

Making a complaint

If you are unsatisfied with the way in which we process your personal data, we ask that you let us know so that we can try and put things right. If we are not able to resolve issues to your satisfaction, you can refer the matter to the Information Commissioner's Office (ICO). The ICO can be contacted at:

Information Commissioner's Office
Wycliffe House
Water Lane
Wilmslow
Cheshire
SK9 5AF
Telephone: 0303 123 1113

Website: Information Commissioner's Office

PART 2 – TAILORED PRIVACY NOTICE

This section of the Privacy Notice provides you with the privacy information that you need to know before you provide personal data to the University for the particular purpose(s) stated below.

Type(s) of personal data collected and held by School of Education and method of collection:

Personal data will be collected through interview, questionnaire and observation form. This will include gender, course year and age. Online questionnaire will be anonymous, and the IP address will not be able to be tracked after finishing the questionnaire. Interview will be audio recorded.

Lawful Basis

The University's core purpose includes undertaking research in the public interest. Processing of your data is carried out as part of this core purpose.

How personal data is stored:

You will be allocated an anonymous number for data collection. Information that identifies you will be kept separate from the anonymised data. All personal data in electronic form will be stored on a password protected computer, and any hardcopies will be kept in locked storage. Data will not be available to anyone outside the research team. *The conversation will be recorded and stored on an encrypted device until it has been transcribed by the researcher. No-one else will have access to the recording, and it will be erased once the transcript has been completed.*

How personal data is processed:

Information will be entered into a database for analysis. After six months the data will be completely anonymised and the original records, including any information which can identify you personally, will be destroyed*. The recorded conversation will be transcribed by the researcher, and personal information will be coded and anonymized. The original recording will then be erased.*

Withdrawal of data

You can change your mind at any time without any repercussions. If you change your mind after data collection, the data collected will be discarded.

Who shares personal data with:

The data will be stored securely in a password protected Windows 10 laptop and be backed up in OneDrive under University email account. The data will not be shared. The identifiable data will be transferred outside the UK/EU.

How long personal data is held by:

The researcher will hold personal data for six months, after which it will be anonymised.

How to object to processing your personal data:

If you have any concerns regarding the processing of your personal data, or you wish to withdraw your data from the project, contact Honghuan Li by honghuan.li@durham.ac.uk or Professor Steve Higgins by s.e.higgins@durham.ac.uk

Further information:

Researcher: Honghuan Li

Department: School of Education

Contact details: honghuan.li@durham.ac.uk

Supervisor: Professor Steve Higgins s.e.higgins@durham.ac.uk

Appendix VI: Debriefing Sheet

Debriefing Sheet

Project title: Pre-service Teachers' Perceptions of ICT and Virtual Reality

Thank you for taking part in this study. The research aims to explore pre-service English teachers' perception of VR technology and their training needs in China. The data you have provided is automatically anonymized and cannot be traced back to your identity. You can change your mind at any time without any repercussions. If you change your mind after data collection, the data collected will be discarded.

If you would like further information about the study or would like to know about what my findings are when all the data have been collected and analyzed, then please contact me on email: honghuan.li@durham.ac.uk. I cannot however provide you with your individual results.