Chinese Physical Education Pre-service Teachers' Beliefs and Knowledge Regarding Self-Regulated Learning

by

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Statement of Originality

I, CAO Yahui, hereby declare that I am the sole author of the thesis and the material presented in this thesis is my original work except those indicated in the acknowledgement. I further declare that I have followed the University's policies and regulations on Academic Honesty, Copyright and Plagiarism in writing the thesis and no material in this thesis has been submitted for a degree in this or other universities.

Abstract

Self-regulated learning (SRL) is a self-directed process through which students self-monitor, self-regulate, and self-control their cognition, motivation, emotion, behavior, and environment to achieve their goals. It involves metacognitive, motivational, and behavioral sub-processes, such as goal setting, planning, learning strategies, self-recording, and self-instructing. Most studies on SRL have focused on academic subjects such as Mathematics and English. However, given the unique characteristics of PE and mainland China and the benefits of applying SRL to PE, this research examined PE pre-service teachers' beliefs and knowledge regarding SRL.

A sequential mixed-methods design was employed with qualitative and quantitative methods. The first phase used the Beliefs about Teaching and Learning 3 (BALT3) questionnaire to collect responses from 385 PE pre-service teachers in mainland China about their beliefs' consistency and inconsistency on SRL. A Rasch model was used for the quantitative analysis of their responses. The second phase interviewed 20 survey participants with different levels of belief consistency with SRL in the semi-structured way to explore their knowledge on SRL. The interview protocol was based on the Zimmerman cyclical model and adapted from Spruce and Bol (2015). Thematic coding was used for the qualitative analysis. The quantitative and qualitative findings were converged to find out the relationship between PE pre-service teachers' beliefs and knowledge, and the influencing factors.

The quantitative results showed that the questionnaire was valid for this research. Studying years, teaching experience, and pedagogical training improved the belief consistency with SRL, but gender did not. These findings revealed the beliefs of PE pre-service teachers on SRL and emphasized the importance of SRL-related learning experience and pedagogical training in mainland China.

The follow-up interviews revealed three types of regulation-related knowledge that explained PE pre-service teachers' learning strategies, the beliefs-knowledge relationship, and the reasons for the relationship. Some interviewees' understanding of SRL was similar to Zimmerman's conceptions. Some stressed peers and teachers more than themselves. Many used different learning strategies for different situations to maximize the efficiency and effectiveness of their learning. The interview participants with higher survey scores were more self-reliant, while those with lower scores depended more on teachers and peers. The PE pre-service teachers' beliefs and knowledge on SRL were influenced by socio-culture and experiences.

The findings showed that PE teachers' training did not cover SRL strategies and concepts much, and PE pre-service teachers knew little about SRL. Teacher education programs should help pre-service PE teachers understand and implement SRL in classrooms. Cultural and social adaption of SRL to mainland China is needed. A mix of self-regulation, co-regulation, and external regulation is found in this study to be mostly applied by PE pre-service teachers in mainland China, and it deserves more research in the future.

Key words: SRL, PE, Pre-Service Teacher, Teachers' Beliefs, Teachers' Knowledge

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While I am typing the section title, the bits and pieces of my study journey in the past are floating in my mind, with some of them about my teachers, some about my family, and some about my friends who helped me along the way. It is the greatest honor and luck to have the company of all of you in my study career!

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List of Abbreviations

SRL	Self-Regulated Learning
PE	Physical Education
RQ	Research Question
BALT3	Beliefs About Learning and Teaching 3
SRLTB	Self-regulating Learning Teacher Beliefs
ConL	Nature of Constructive Learning
NatL	Quick and Natural Learning
ConT	Constructive Teaching
TranT	Transmissive Teaching
SRLAc	SRL Achieve
SRLNeg	SRL Negative
LoLC	Locus of Learning Control
MVPA	Moderate to Vigorous Physical Activities
OME	Ontario Ministry of Education
ESSA	Every Student Succeeds Act
NCLB	No Child Left Behind Act
NASPE	National Association and Physical Education
MSLQ	Motivated Strategies for Learning Questionnaire

TAM	Test Analysis Modules
AIC	Akaike Information Criterion
AIC3	Akaike Information Criterion with Coefficient of 3
BIC	Bayesian Information Criterion
aBIC	Adjusted Bayesian Information Criterion
CAIC	Consistent Akaike Information Criterion
AICc	Bias Corrected Akaike Information Criterion
GHP	Gilula-Haberman Log Penalty

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Chapter 1. Introduction

1.1. Research Background

Self-regulated learning (SRL) is a self-directed process through which students self-monitor, self-regulate, and self-control their cognition, motivation, emotions, behavior, and environment to achieve their learning goals (Efklides et al., 2002). This form of learning involves metacognitive, motivational, and behavioral subprocesses, such as goal setting, planning, learning strategies, self-recording, and self-instructing, which individual students initiate to acquire knowledge and skills (Zimmerman & Schunk, 2001). SRL has been widely recognized as an effective strategy for teaching and learning (Dignath-van Ewijk & van der Werf, 2012; Karlen et al., 2020). The cultivation of SRL has presented as a comprehensive approach that involved the whole school and required a focus on the holistic development of students. The theoretical underpinnings of SRL and its substantial impact on students' learning and development in the 21st century was also identified in the previous study (Taranto & Buchanan, 2020). However, despite the broad recognition of its importance, most studies on SRL have focused on academic subjects. While SRL has been shown to be an effective strategy for improving learning outcomes, it is equally important for the cultivating skills beyond traditional academic domains, such as Physical Education (PE).

In line with relevant views in the field of sports (Zimmerman, 2015), researchers have suggested that in order to better develop motor skills, students need to hold SRL strategies. The existing research has indicated that recording oneself, reflecting, regulating oneself, and setting goals can help learners achieve better motor performance (Kolovelonis, Goudas, & Gerodimos, 2011) and increase their daily sports activities (Shimon & Petlichkoff, 2009). Empirical studies have reported that compared with students who employ weak SRL strategies, those who use strong SRL strategies are better able to learn a new sports skill and engage in high-intensity physical activity, which is conducive to a healthy lifestyle (Kitsantas et al., 2000; Shimon & Petlichkoff, 2009). However, PE teaching is a multidimensional and complex task (Graham, 2008). In PE, students learn a variety of skills related to sports and physical activity, such as throwing, catching, and running. These skills may require specialized instruction and coaching, which is different from the more traditional lecture-based instruction in academic subjects (de la Fuente et al., 2020; Müller & Seufert, 2018). Additionally, PE always needs collaboration with others, such as teamwork, communication, and resilience, through activities such as team sports and group exercise (Reeve & Tseng, 2011).

The role of teachers in the learning process is crucial (Azevedo et al., 2008; Paris & Paris, 2001). Teachers are responsible for designing and implementing effective instructional strategies that promote learning and development in their students (Dignath-van Ewijk & van der Werf, 2012; Spruce & Bol, 2015). Thus, it is important for teachers to possess a deep understanding and belief of the various learning strategies and to choose appropriate methods for use in the

classroom. Before entering service, the training and experience in college may be critical for teachers' beliefs and knowledge in SRL. To effectively promote SRL, it is important for pre-service teachers to possess a thorough understanding of regulation learning theory and its practical applications. This requires ongoing professional development and training to ensure that teachers are equipped with the necessary knowledge and skills to promote SRL in their classrooms. Furthermore, it is necessary to differentiate between the constructs of beliefs and knowledge clearly. While beliefs are generally considered to be more effective, knowledge is considered to have higher epistemic status due to its greater justifiability when compared with beliefs (Pajares, 1992). To investigate the effects of beliefs and knowledge on teacher decision-making and problem-solving, it was important to know the connection between the two (Dignath-van Ewijk & van der Werf, 2012; Lombaerts et al., 2009; Spruce & Bol, 2015). Thus, understanding pre-service teachers' beliefs and knowledge, as well as the interrelation between beliefs and knowledge, can help in the development of effective recommendations for SRL promotion. By identifying areas where teachers may require additional training or support, it is possible to design targeted interventions that can help improve the quality of SRL promotion in schools.

Last but not least, the concept of "self" has been widely studied and emphasized in the fields of education and psychology in Western countries. Self-concept, self-efficacy, self-monitoring, self-regulation, and other self-related concepts were considered important factors in students' learning and development (Lee et al., 2021; Lee, 2022; Toharudin et al., 2019). In contrast, In

China, teachers were often regarded as central authorities in classrooms and had a high degree of control over what happened in classrooms. Students learned in teacher-centered classrooms, and they were more accustomed to and trusted the teacher's arrangement. In addition, the examination system in China was believed to be a factor strongly affecting students' self-regulated learning. In China, the college entrance exam was a crucial test that determined whether a student could enter a higher education institution. As a result, many students put all their efforts into preparing for the exam and neglected the importance of study strategies.

Therefore, this research aimed to assess the beliefs in SRL and to investigate the knowledge on SRL held by Chinese PE pre-service teachers, and their relationship and reasons behind the observed. By combining the characteristics of PE and the Chinese cultural context, recommendations can be made to enhance the development of more helpful strategies for SRL.

1.2. Underlying Theories

Researchers and educators have identified self-regulated learners as the most effective learners in traditional learning environments (Boekaerts, 1999). Students drive their learning processes and take responsibility for their learning performance through metacognition, motivation, and behavior (Zimmerman, 1989). Dignath and Büttner (2008) found that children and teenagers who were good at SRL performed better at school than did their counterparts who were bad at SRL, indicating the importance of SRL to educational achievement. The more

learners regulate themselves, the more motivated they seem to be to pursue academic achievement and the more practical learning skills they seem to possess (Pintrich, 2004). In addition, Zimmerman and Kitsantas (2002) found that highly self-regulated learners were more likely to achieve academic success and be optimistic about their future. Therefore, the researchers emphasized that SRL is a learning skill that promotes lifelong learning. In the last 40 years, research has focused on two main aspects of SRL: students and teachers. First, researchers have investigated the relationship between students' achievement and SRL (Dent & Koenka, 2016; Zimmerman, 2000; Zimmerman & Schunk, 2001) and measured students' SRL skills (Rahayu et al., 2020; Roll & Winne, 2015). Research has shown that SRL has significant positive effects on students' learning motivation (Efklides et al., 2018), academic achievement (Cleary & Kitsantas, 2017; Wolters & Hussain, 2014), and learning satisfaction (Mega et al., 2014). Second, focusing on teachers, researchers have discussed the importance of achieving SRL in classrooms (Verma et al., 2019). For instance, studies have shown that teachers' SRL teaching strategies, knowledge, and practice significantly affect their the quality of their instruction (Dignath, 2016; Dignath-van Ewijk & van der Werf, 2012; Paris & Paris, 2001; Spruce & Bol, 2015).

Puustinen and Pulkkinen (2001) provided a relatively comprehensive review of SRL models developed before 2001. Building on their research, Panadero (2017) added some new SRL models developed in the previous decade and summarized six high-level models. Zimmerman's (2000) model was developed based on social cognitive theory and is among the most widely

used learning models in classrooms. This model emphasizes the importance of motivational factors and learning strategies in creating environments that can help students achieve high levels of SRL. This study used Zimmerman's model to understand SRL strategies (Zimmerman, 2000).

1.2.1. SRL and Zimmerman Model

Studies (Kitsantas & Zimmerman, 1998; Zimmerman, 2000) have suggested that SRL is a circular process in which reflecting on and learning from past experiences lead to improvements in future learning outcomes. According to Zimmerman (2015), "SRL" refers to the process through which students become masters of their own learning processes. Self-regulation is not a mental ability or a performance skill but a self-directed process through which learners transform their mental abilities into task-related skills in diverse areas of functioning, such as academia, sports, music, and health.

Zimmerman's cyclical model consists of three phases: forethought, performance, and self-reflection. During the forethought phase, which occurs before learning, learners analyze tasks (i.e., setting goals and planning strategically) and develop self-motivated beliefs, including self-efficacy, outcome expectations, intrinsic interests or values, and goal orientation. Next, during the performance phase, which occurs during the learning process, learners engage in self-control processes (i.e., self-direction, concentration, and task strategies) and self-observation (i.e., self-recording and self-experimentation). Self-reflection, which is the third stage, occurs after the learning process and involves self-judgment (i.e., self-assessment and causal attribution) and

self-reaction (i.e., self-satisfaction or emotion, adaptive or defensive reactions) (Wong et al., 2019). These stages occur sequentially during the learning process. Once the last stage is complete, the first stage starts again, forming a loop. At a high level, SRL involves setting and achieving goals as well as determining requirements and methods to achieve those goals (Dabbagh & Kitsantas, 2012).

1.2.2. SRL in Physical Education

In line with relevant views in the field of sports (Zimmerman, 2015), researchers have suggested that motor skills development requires talent and high-level instruction and that students need to develop SRL skills (Ommundsen & Lemyre, 2007). Most research on SRL in sports has focused on techniques for teaching specific sports skills (Kolovelonis & Goudas, 2012; Kolovelonis, Goudas, & Dermitzaki, 2011; Kolovelonis et al., 2012). However, little attention has been paid to general sports-related pedagogical strategies implemented in school settings. In a study by Kolovelonis et al. (2012), 100 fifth- and sixth-year students in primary school (including 40 boys and 60 girls) underwent training in dribbling. Four groups used the experimental SRL method, and one group used the classical method for comparison. The students instructed using the SRL method showed an improvement in performance in throwing dribbles from the pretest to the posttest. However, the control participants did not show any marked difference in their performance. The SRL literature has indicated that recording oneself, reflecting, regulating oneself, and setting goals can help learners achieve better motor

performance (Kolovelonis, Goudas, & Gerodimos, 2011) and increase their daily sports activities (Shimon & Petlichkoff, 2009). For example, Zimmerman and Kitsantas (1997) conducted an experiment in which girls practiced throwing darts. The results revealed that girls who set goals, self-recorded, and provided feedback performed better than the control group in dart-throwing. In addition, Zimmerman and Kitsantas (1997) emphasized that SRL strategies can improve the effectiveness of emotional learning, such as self-efficacy and satisfaction, by enabling students to recognize their progress in mastering new skills in the process of meeting the set goals (Zimmerman & Schunk, 2004). Studies have indicated the importance of incorporating SRL strategies into PE education. However, the integration of SRL strategies into students' learning and daily practice requires teachers' explicit instruction.

1.2.3. Teachers' Beliefs and Knowledge Regarding SRL

Belief is a subjective cognitive experience (Pehkonen & Pietilä, 2003), usually defined as a judgment based on personal experience (Raymond, 1997). Teachers' beliefs are commonly regarded as personal structures that enable them to understand, evaluate, and assess their daily activities (Pajares, 1992). Teaching beliefs guide experienced teachers in managing classrooms, determining teaching strategies, setting reasonable expectations for students, and developing professional knowledge (Levin, 2015; Levin et al., 2013). Teachers' beliefs about SRL reflect their perceptions of the extent to which SRL capability is necessary and appropriate for students' learning. In some research, teachers' beliefs have been considered pedagogical beliefs that guide

certain SRL issues (Dignath, 2016). Some researchers have divided teacher beliefs into those consistent with SRL and those inconsistent with SRL (Darmawan et al., 2020; Lawson et al., 2019; Vosniadou et al., 2020). By clearly distinguishing these beliefs, researchers can analyze teachers' practice and guide teachers more effectively. Educators can also benefit from a comprehensive understanding of how SRL occurs in classrooms by analyzing teachers' SRL beliefs (Vosniadou et al., 2020).

"Teacher knowledge" refers to all of the knowledge that a teacher has mastered at a given point in time, which forms the basis for guiding the teacher's behavior (Carter, 1990). In-service and pre-service teachers acquire their knowledge from various sources, such as class experience and teaching training. Training encompasses pre-service teacher training prior to entering the profession and continuing education for in-service teachers (Calderhead, 1996). Shulman (1986) reported that most educational researchers attach great importance to teachers' pedagogical knowledge, content knowledge, and pedagogical content knowledge. "General pedagogical knowledge" refers to teachers' understanding of teaching principles and rules for managing and organizing instruction in various courses. Content knowledge represents the materials that teachers teach students to know, practice, and master in various subjects. Pedagogical content knowledge combines teachers' knowledge of teaching strategies and knowledge of the content taught to their students, with a focus on teaching such that students can understand and absorb the content. In the context of SRL, content knowledge covers teachers' understanding of fundamental concepts relevant to the classes they teach, such as subject terms, theoretical

models, and how the SRL process is implemented in their classrooms (Kramarski & Michalsky, 2010). Pedagogical content knowledge includes teachers' knowledge of how to develop and implement SRL in the classroom and help students to acquire SRL skills. This knowledge covers various teaching methods used to promote SRL directly or indirectly (Paris & Paris, 2001). The latter can be achieved by encouraging students to engage in SRL and creating suitable environments and opportunities for SRL (De Corte et al., 2004; Perry et al., 2008). Some researchers have assessed the influence of teachers' knowledge of SRL on their ability to apply SRL successfully in their teaching (Dignath-van Ewijk & van der Werf, 2012; Spruce & Bol, 2015; Xu & Ko, 2019).

All of the cited research in the above paragraphs as indicated that appropriate beliefs and knowledge regarding SRL are necessary to effectively implement SRL strategies in classrooms. Most of these studies have focused on academic subjects. Among those examining PE, the majority have focused on improving students' sports performance. However, PE teachers are also worthy of attention. It is important to investigate PE teachers' beliefs and knowledge regarding SRL and how they can develop SRL strategies when teaching PE subjects. This study attempted to fill the gap in research in this area.

1.3. Policies

1.3.1. Development of SRL-Related Policies in School Curriculums

The Every Student Succeeds Act (ESSA) took effect on December 15, 2015 in the United States, with the aim of ensuring that every student has the same opportunities to access high-quality education. Essentially, this law replaced the No Child Left Behind Act (NCLB) implemented in 2002. The ESSA laid an important foundation for ensuring that teachers apply equal education standards to help students achieve learning outcomes. Following the passage of the NCLB, the United States Department of Education provided guidance to shift the focus of K-12 instruction from a teacher-centered approach to a student-centered approach (Ornstein & Hunkins, 2018). Thus, the Department of Education began to emphasize the equity of education and the enhancement of students' learning skills. The Finnish Education Authority published the Framework for Assessment of Educational Outcomes in 1995, which highlighted lifelong learning competence and motivation to learn as its main goals. Under this framework for improving their learning capability, students became more able and willing to adapt to new environments. They demonstrated the ability to voluntarily and effectively master new learning behaviors (Hautamäki & Kupiainen, 2014). Curriculum reforms undertaken in Hong Kong since 2000 have been designed to adapt to the ever-changing economic and technological landscape of the 21st century. The notions of "learning to learn" and "lifelong learning" have become the central themes of the curriculum in Hong Kong. Self-directed learning was introduced as one of

the nine prescribed learning areas. In addition, developing students' capacity for self-directed learning is the main goal of curriculum reforms in mainland China. As indicated in the Overview of Basic Education Curriculum Reforms, the primary goal is to create a curriculum that imparts knowledge to students and emphasizes the cultivation of a positive learning attitude.

The aforementioned measures indicate that enhancing students' motivation and ability to learn and promoting lifelong learning are educational goals emphasized by some countries. In different countries, policymakers and educators have used various terms to achieve the same outcomes as those of SRL, including self-directed learning, autonomous learning, independent learning, and self-study. Researchers have emphasized that the core aim of education is to cultivate the ability to learn and promote lifelong learning. This represents a notable developmental direction for curriculum reforms in primary and secondary schools. The importance of achieving these outcomes is not limited to specific school subjects. Instead, they are considered common teaching goals for each subject in school (Lin et al., 2021).

1.3.2. PE Curriculums in Different Countries

In their study of PE teaching, Gallahue and Donnelly (2007) indicated that PE teachers should set clear and measurable goals and systematically design and implement course plans to achieve these goals. Many countries have established programs to improve the quality of PE instruction.

Standards developed by the National Association for Sport and Physical Education in the United States (NASPE, 2004) emphasize that PE teachers should encourage students to acquire sports skills and learn how to control their cognition and emotions. In the United States, PE targets to "develop physically literate individuals who have the knowledge, skills, and confidence to engage in healthy physical activity throughout their lives," as described in "SHAPE America's National Standards & Grade-Level Outcomes" (*National Physical Education Standards-SHAPE America Sets the Standards*, 2013). In the United States, most schools require children and young people aged from 6 to 17 to engage in moderate to vigorous physical activity (MVPA) for at least 1 hour every day (Health.gov, 2018). In Canada, based on a report published by the Ontario Ministry of Education (OME) in 2005, the OME introduced a policy mandating daily physical activity in elementary schools. Under this policy, students must be given opportunities to engage in MVPA for at least 20 to 30 minutes per day (U.S. Department of Health and Human Services, 2019). In New Zealand, the government introduced curriculum reforms that required teachers to focus more on students' physical and mental health by guiding and encouraging them to engage in physical activity (Ministry of Education, 2007). The revised curriculum also places a strong emphasis on developing students' critical thinking skills related to their personal and social well-being and the value of physical activities. In 2006, the Ministry of Education and Religious Affairs in Greece (HMERA, 2006) revised the high school PE curriculum to help students develop self-regulation techniques and life skills conducive to a healthy and active lifestyle (Goudas et al., 2006; Papaioannou et al., 2007). In

Greek high schools, the PE curriculum is focused on promoting students' physical and psychological development as well as their social and moral growth (HMERA, 2006).

In recent years, PE has become increasingly important in mainland China. In 2019, the General Office of the State Council issued the Guideline for Building China into a Strong Country through Sports, which outlined a plan to improve youth sports and enhance students' physical fitness and health by 2035. This blueprint is worthy of consideration by all researchers studying sports. School educators in China were tasked with creating a good PE environment and instilling a habit of playing sports among students. In 2020, the General Administration of Sports of China and the Chinese Ministry of Education launched a policy to encourage young people to improve their health. The policy emphasized the importance of promoting PE in schools and improving the training of PE teachers, such as by including a PE exam in the "Zhong-Kao" which is short for the High School Entrance Examination and "Gao-Kao," which is the National College Entrance Examination, enriching extracurricular physical activities and encouraging students to engage in 1 hour of physical activity every day after school. In May 2021, Chinese education authorities proposed the "double reduction" policy. This policy aimed to reduce students' homework burden during compulsory school hours and unnecessary extracurricular activities, leaving more time for PE and art classes. These policies reflect the government's awareness of the importance of PE in promoting students' all-round development. However, students need efficient techniques to manage their time and plan their exercise goals.

Armour and Yelling (2004) reported that teachers' teaching strategies can affect students' learning habits; therefore, teachers should adopt scientific teaching methods (Armour & Yelling, 2004; Syrmpas et al., 2017). Empirical studies on school-based PE education have shown that self-regulation strategies can promote students' development of motor skills and increase their level of physical activity, thus enabling them to achieve a healthy lifestyle (Kitsantas et al., 2000; Shimon & Petlichkoff, 2009). In the UK, for example, developing SRL in PE is one of the key aims of the National Physical Education Curriculum (Gov.uk, 2013), which required students to plan and evaluate their participation in PE and encouraged teachers to implement SRL in PE classes.

Although SRL is mentioned in many school syllabi and education policies, how teachers should teach and apply SRL in the classroom, especially in PE, remains unclear. Many studies have highlighted the importance of PE for students' physical and mental health. However, there appears to be a lack of clear teacher manuals on how to cultivate students' habit of SRL instead of simply completing the required curriculum courses. Therefore, in terms of policies, teachers require clear instructions to implement SRL strategies in both academic and PE classes.

1.4. Applications of SRL in Teaching Practice in Schools

Studies have highlighted the importance of encouraging students to develop SRL. However, school curriculum quality is largely dependent on teachers (Liu et al., 2018; Ward, 2014). Teachers' history and experience of SRL affect their future professional competence as SRL

practitioners and the related teaching strategies they employ in the classroom (Gordon et al., 2007; Paris & Winograd, 2001). The intentional development of SRL can enable educators to gain a deeper understanding of students' planning, performance, and reflection capabilities. Moreover, it can help teachers better identify and respond to demands, limitations, and obstacles that students might encounter during their learning process and instill discipline in students (Peeters et al., 2014; Randi, 2004). Effective educators are also self-regulating learners because they know what SRL is and how to use it. The use of SRL strategies while teaching enables teachers to identify challenges and adjust their teaching methodologies and instructional practices accordingly, ensuring that instruction runs smoothly and students achieve the desired learning outcomes (Askell-Williams et al., 2012; Paris & Winograd, 2001).

The literature has provided two key examples of teachers practicing SRL in the classroom. The first is from a chemistry class at an American school. Two teachers used the SRL instructional model and Zimmerman's cyclical model to design lesson plans. They divided each lesson into three phases: a home video preview phase, an in-class discussion phase, and a post-class reflection phase. The results revealed that students' grades improved because they had a stronger motivation to learn and a more active sense of participation in class (Bergmann & Sams, 2012).

The second example is from a PE class at a university in mainland China. The teacher used the SRL method in volleyball training. The results revealed that the implementation of the SRL method significantly improved students' volleyball performance. The teacher identified three

main reasons for this improvement. First, students could reflect and summarize their practice tasks more effectively. Second, SRL instruction stimulated students' learning motivation, improving their enthusiasm for and initiative in learning volleyball. Third, students could actively participate in setting individualized learning goals and planning strategies (Rong, 2016).

The aforementioned findings indicate that the incorporation of SRL strategies in teaching places high demands on teachers. To implement SRL effectively, teachers should have beliefs consistent with SRL and knowledge of SRL strategies. Although many of the teachers were confident about SRL, they still experienced difficulty while implementing it in the classroom, potentially because they did not possess adequate knowledge. Thus, to better adapt to SRL development, attention should be paid to teacher education, especially for pre-service teachers.

1.5. Research Significance

1.5.1. Significance of Physical Education

PE teaching is indeed a complex and multidimensional task (Graham, 2008), as it involves a range of skills and knowledge related to sports and physical activity. In PE classes, students learn a variety of skills such as throwing, catching, running, and other motor skills, which require specialized instruction and coaching. This differs significantly from the more traditional lecture-based instruction used in academic subjects, as PE instruction involves a more hands-on approach that focuses on the development of physical skills (Varea et al., 2022).

Furthermore, PE activities often require collaboration and teamwork, which can promote the development of social and emotional skills such as communication, leadership, and resilience (Strong et al., 2005). Participating in team sports and group exercise activities can help students develop these skills by providing opportunities for them to work with and learn from their peers (Tomik et al., 2012). It is the responsibility of PE teachers to foster these skills in their students and to create an environment that promotes collaboration and teamwork.

Overall, PE teaching requires a diverse set of skills and knowledge. PE teachers should be well-versed in motor development, biomechanics, sports psychology, and other related areas. They must also be able to effectively teach physical skills using appropriate instructional strategies and promote personal development and teamwork among students.

1.5.2. Significance of Studying SRL in Physical Education

The Zimmerman SRL cyclical model focuses on how individuals improve their learning to adapt to changing environments in a cyclical and systematic way. However, this model is not widely used in the context of changing physical activity behavior. At present, most of the studies on the Zimmerman cyclical model were started in academic subjects and it was proven to have a positive effect on students, such as in linguistics, mathematics, science, etc. The literature review showed that models using self-regulation strategies in the field of sports focused on Zimmerman's multi-level training model because it is more helpful for training students to learn new sports skills (Kitsantas et al., 2000; Kolovelonis & Goudas, 2013; Zimmerman, 2000).

However, when students are mastering skills, they should self-direct practice, and self-monitor their performance. Then, they will return to the cyclical model to manage and make plans for daily practice. Therefore, students need a method not only for the moment of learning but also for further practice.

Pitkethly et al. (2019) looked at the relationship between SRL skills and physical activity in adolescents and showed that despite differences in physical activity, a similar pattern emerged in the relationship between SRL and physical activity in both participating groups, and the importance of reflection in this relationship. The conclusion is that SRL skills are not necessarily innate for adolescents and may require explicit training. Therefore, a focus on the development of SRL skills as well as PE research, with a special emphasis on reflection, may have a positive impact on changes in adolescents' physical activity behavior. As a result, studying the SRL cyclical model in PE also is significant.

1.5.3. Significance of Teachers' Beliefs and Knowledge Regarding SRL in Physical Education

"SRL" refers to the capability of an individual to direct, monitor, and regulate learning goals in an autonomous and controlled manner (Paris & Paris, 2001). Incorporating SRL strategies during teaching requires active participation from teachers (Azevedo et al., 2008; Paris & Paris, 2001) because they need to create a learning environment that supports SRL. However, the use of instructional strategies depends on teachers' beliefs and knowledge. The teacher education program is a crucial medium for training normal PE college students. Most studies focused on

SRL in academic subjects, such as mathematics, English, etc. However, PE may have unique characteristics that make it distinct from other academic subjects, highlighting the need for tailored strategies that take into account these specific features. By combining the features of PE and the Chinese cultural context, recommendations can be formulated to enhance the development of more effective SRL strategies that align with the unique requirements of PE and the cultural context. Therefore, assessing Chinese pre-service teachers' beliefs and knowledge regarding SRL is crucial during curriculum preparation, especially in PE.

1.6. Research Gap

There has been some existing research to explore teacher beliefs and knowledge regarding SRL. Some research examined teachers' beliefs regarding SRL (Darmawan et al., 2020; Lombaerts et al., 2009). Some studies analyzed the instructing strategies applied by instructors in classrooms, with the purpose to understand how to incorporate SRL in the teaching practice (Dignath-van Ewijk & van der Werf, 2012; Spruce & Bol, 2015). Some papers explored the role of SRL in learning sports skills (Kolovelonis & Goudas, 2013; Zimmerman & Kitsantas, 2005). Some papers focused on guiding the students in normal colleges to improve their expertize on metacognition and SRL (Perry et al., 2008; Zhang, 2010). Last but not least, there were also some researchers who evaluated the effects of the professional continuing training of teachers' SRL knowledge (Rahayu et al., 2020; Xu & Ko, 2019).

However, most of these studies were related to teachers and students in academic courses, or only focused on training sports skills. Research on PE related to SRL pre-service teachers' knowledge and beliefs are very limited. The study introduces in this research aimed to assess the beliefs in SRL and to investigate the knowledge on SRL hold by PE pre-service teachers, and how beliefs regarding SRL relate to their knowledge. Also, to explore why they presents different beliefs and knowledge. More specifically, this research is conductive. Research on SRL for PE pre-service teacher is very vital to fit in China's learning environment.

1.7. Research Questions

This study proposed and answered the following two research questions:

1. What are the beliefs and knowledge of Chinese PE pre-service teachers regarding SRL?
    a) What are the beliefs of Chinese PE pre-service teachers regarding SRL?
    b) What is the knowledge of Chinese PE pre-service teachers regarding SRL?
    c) How do the beliefs of Chinese PE pre-service teachers regarding SRL relate to their knowledge of SRL?
2. How are PE pre-service teachers' beliefs and knowledge shaped?

1.8. Overview of Subsequent Chapters

In Chapter 2, definitions and models of SRL, as well as research on teacher beliefs and knowledge, are reviewed. In addition, the importance of SRL strategies in sports is discussed. Some studies have examined teachers' beliefs regarding SRL (Darmawan et al., 2020; Lombaerts et al., 2009), analyzed instructional strategies applied by instructors in classrooms to incorporate SRL into teaching practice (Dignath-van Ewijk & van der Werf, 2012; Spruce & Bol, 2015), explored the role of SRL in learning sports skills (Kolovelonis & Goudas, 2013; Zimmerman & Kitsantas, 2005), guided students in normal colleges to improve their expertise in metacognition and SRL (Perry et al., 2008; Zhang, 2010), and evaluated the effects of the professional continuing training of teachers' SRL knowledge (Rahayu et al., 2020; Xu & Ko, 2019). However, there has been limited research on teachers' and students' SRL in subjects that focus on personal development, such as PE. Therefore, through a literature review, the need for research on this topic was identified.

Chapter 3 introduces the application of mixed methods in this study. The process of selecting the sample population and the general characteristics of the participants are discussed. Details of the research tools, including the questionnaires, interview protocols, and methods of disseminating the tools to the participants, are provided. In addition, the data analysis is discussed in Chapter 3.

Chapter 4 presents the results of the questionnaires and interviews. Statistical analysis of the

questionnaire results and thematic analysis of the interviews were conducted. The relationship between PE pre-service teachers' beliefs and knowledge was examined by combining the quantitative and qualitative results. Finally, the sources of the participants' beliefs and the knowledge and factors that might affect them were identified.

Finally, in Chapter 5, the research results are discussed. The consistency of the PE pre-service teachers' beliefs with SRL are discussed, along with some potential explanations for the findings. In addition, the limitations of the study are mentioned. Finally, suggestions for future research and implications for pre-service PE teachers in China are provided.

Chapter 2. Literature Review

2.1. Self-regulated Learning (SRL)

2.1.1. Definition of SRL

Self-regulated learning (SRL) refers to a process directed by the learners themselves. In this process, they supervised, administered, and guided their own attention, comprehension, emotion, initiatives, and activities to pursue their targets (Efklides et al., 2002). A key element of SRL is self-regulation, which refers to "self-generated thoughts, feelings, and actions to achieve personal goals" (Zimmerman, 2000, p. 14). Self-regulation means metacognitive, motivational, and behavioral. It helped individuals develop their capabilities to become knowledgeable and skilled in setting goals, making plans, and setting learning strategies (Efklides, 2011). Through self-regulation, individuals are able to monitor their progress, evaluate their performance, and adjust their strategies accordingly. This allows them to take control of their own learning and become more independent learners. Furthermore, learners who could regulate themselves usually recorded and reinforced themselves to meet higher discipline standards (Zimmerman & Schunk, 2001). They are good at organizing, directing, monitoring, and evaluating themselves in the process of learning. As a result, the learning process is invigorated by their active participation (Efklides, 2005; Zimmerman, 1986), and they are able to achieve the desired academic performance (Torrano & González-Torres, 2004).

Over the past 40 years, researchers have divided their research into two areas: students and teachers, and they have come to some conclusions. First, regarding students, researchers have highlighted the impact of SRL on students, for example, by investigating the connection between students' learning performance and SRL (Dent & Koenka, 2016; Zimmerman, 2000) and measuring students' SRL capability (Rahayu et al., 2020; Roll & Winne, 2015). Some research showed that SRL can improve students' motivation to learn (Zimmerman, 2002), cultivate critical thinking, and enhance students' lifelong learning capabilities (Dignath et al., 2008). Pintrich and Zusho (2002) showed learners who can self-regulate their learning process usually had better results than those who failed to self-regulate and had a higher possibility to succeed in schools and keep learning throughout their whole life.

Second, some researchers have discussed the importance of teachers in SRL instruction (Dignath et al., 2008; Dignath & Büttner, 2008; Kistner et al., 2010; Perry et al., 2008; Spruce & Bol, 2015; Verma et al., 2019). First of all, several researchers found that learners understood SRL better by studying in a classroom environment. If teachers created an environment that promoted SRL, it was easier for the learners to be motivated, leading to excellent educational outcomes (Zimmerman & Bandura, 1994). Dignath and Büttner (2008) studied the impact of putting blockers to stop students from adopting SRL. In their study, they conducted two experiments with meta-analysis in elementary schools and secondary schools. The meta-analysis included 49 analyzes in elementary schools and 35 analyzes in secondary schools. The results showed that students did better when they learnt with researchers than regular teachers. In other

words, researchers were more knowledgeable regarding SRL strategies than regular teachers, and their understanding of SRL concepts was more accurate. The results of the intervention showed that primary and secondary students could effectively promote SRL and achieve significant results in literacy and mathematics. In addition, educators emphasized the impact of teaching strategies, skills, and practices in the SRL way in classrooms (Dignath, 2016; Dignath-van Ewijk & van der Werf, 2012; Paris & Paris, 2001; Spruce & Bol, 2015). As suggested by Perry et al. (2008), teachers were encouraged to create an environment for students that promoted SRL and to apply scaffolding strategies. It was important to guide students such that they could apply the SRL methods independently. By engaging in SRL scaffolding, students first became knowledgeable about self-discipline under the guidance of teachers, then became knowledgeable regarding SRL through modeling and receiving instructions, and lastly, by reflecting and giving feedback. In a nutshell, teachers were the key to designing SRL lessons and providing guidance to use SRL strategies.

2.1.2. SRL Model Reviews

A lot of papers in the literature started basing themselves on SRL since the 1980s, when educational psychologists began to study it (Dent & Koenka, 2016) and many models have been proposed (Boekaerts, 1999; Borkowski, 1996; Butler & Winne, 1995; Pintrich, 2000; Winne et al., 1998; Zimmerman, 2000).

2.1.2.1. Puusstinen and Pulkkinen's (2001) Review

Puustinen and Pulkkinen (2001) conducted a comprehensive review of five SRL models that were supported by numerous empirical research studies. The models were developed by Boekaerts and Niemivirta in 2000, Borkowski in 1996, Pintrich in 2000, Winne and Hadwin in 1998, and Zimmerman in 2000. When reviewing these five models, Puustinen and Pulkkinen (2001) divided their definitions into two types, goal orientation (Boekaerts, Pintrich, and Zimmerman) and metacognition (Borkowski and Winne). These researchers viewed SRL as a process that encompasses the preparation phase, the actual execution or task performance phase, and the evaluation or adjustment phase. However, each model had a different focus. For example, Boekaerts' SRL model mainly emphasized the preparation stage of the learning process rather than the execution and evaluation stages (Panadero, 2017). The research done by Boekaerts and Pintrich was mainly about the motivation, while the research from Borkowski and Winne focused on the strategy. Last but not least, the research from Zimmerman was based on motivation and strategies.

2.1.2.2. Panadero's (2017) Review

Later, as researchers updated the SRL model in practice, some models were deleted, and some new models were added. Panadero (2017) selected six SRL models and four research directions in his review. When selecting the models, he first analyzed them from Puusstinen's

and Pulkkinen's reviews that were still used, namely Boekaerts, Winne, and Zimmerman. Pintrich was unable to enhance his analysis (Limon et al., 2004), even though the associated model and questionnaire, called the Motivated Strategies for Learning Questionnaire (MSLQ) (Pintrich et al., 1993), are well known and broadly employed in papers (Moos & Ringdal, 2012), so the author also considered the scope. However, Borkowski et al. (2000) noted that metacognition-based models have been used less frequently in SRL development recently, and the authors shifted their research topics to "exceptions" (i.e., learning disabilities). As a result, it was not included. Second, he has used two new models for review. The model by Efklides (2011) examined how emotions and initiative impact metacognition. In the research done by Hadwin and Oshige (2011), their model solved the issue of cooperative learning, which has become a new research direction in SRL (Panadero & Järvelä, 2015). Panadero (2017) divided the model into three categories: cognition, motivation, and emotion.

Cognition. First, as for (metacognitive) cognition, Panadero (2017) emphasized that Winne and Hadwin's model was metacognitive: "Metacognitive monitoring was a portal to SRL" (Winne & Perry, 2000, p. 540). Second, although Efklide's model emphasized emotion and motivation, the Task × Person level provided a more detailed explanation and more content in metacognition. Finally, although Pintrich and Zimmerman's model included metacognitive regulation and metacognitive strategy, it was based on motivation.

Motivation. Motivation was an integral component of the models of Zimmerman, Boekaerts, and Pintrich. The definition of SRL by Zimmerman clarified the significance of goals

by defining SRL as an activity oriented toward achieving specific results. Specifically, self-motivated beliefs played an important role within the anticipatory phase of his model. The acting stage was initially depicted as acting/volitional controls, indicating the importance of volitional control; self-reaction might influence motivation to perform future tasks in the self-reflection phase (Zimmerman, 2000). Boekaerts contended that students engage in two different goal pathways after they have "interpreted" the learning task and context. Students guided these pathways to perform (or not perform) activating supervisory actions (Boekaerts & Niemivirta, 2000). Furthermore, Boekaerts incorporated motivational beliefs into her model of SRL, which was a key feature of the framework. Lastly, Pintrich (2000) has included a motivational and influential aspect in his model that reflected some of the same aspects as the one from Zimmerman, even though Pintrich highlighted more importance of metacognition than Zimmerman does. What was more, Pintrich carried out the first study to examine how goal orientation works in SRL (Pintrich & De Groot, 1990).

Emotions. Based on Boekaerts (1999), emotions had a significant impact on learners in their pursuit of goals. Self-protection was another important factor that affected the well-being of learners, so they should have rules and plans to control their emotions to remain on the path of learning. It has been argued by Oates et al. (2019) that when students were equipped with good voluntary strategies and showed good learning patterns, they had a higher possibility of devoting time and effort to their learning and losing joy when a stressor interrupted their progress.

2.1.2.3. Other Researchers' Review

The classification of SRL models into process models and component models has been discussed by some researchers (Lehmann et al., 2014; Steinbach & Stoeger, 2016). SRL could be modeled by splitting it into different stages of equal importance and significance (Zimmerman & Martinez-Pons, 1988). It was broadly admitted that Zimmerman's three-stage process model includes forethought, performance, and self-reflection. There were different principal tasks involved in different stages, including goal setting, monitoring, observing, assessing, and reflecting (Zimmerman, 2000). The second type was about components and described the features and capabilities. These components were important because they helped learners exercise self-regulation in the learning process (Boekaerts, 1999; Pintrich, 2000). For example, Boekaerts (1999) described SRL as a variety of components that interact with each other. In Boekaerts' (1999) model, the SRL was composed of three levels: the innermost level denoted cognitive strategies, the middle level indicated learning management, and the outermost level consisted of students' ego systems, such as goals, motivations, and emotions.

Pintrich and Zimmerman's model had the same theoretical background, which was social cognition theory. These two models were also the most widely used (Panadero, 2017), as both models developed by Pintrich and Zimmerman provided more comprehensive explanations of the different types of subprocesses, which were simpler to accept and to adopt in the classroom setting (Dignath et al., 2008). Compared with Boekaerts, Pintrich and Zimmerman presented

more specific subprocesses and appeared to incorporate aspects of motivation and emotion that Hadwin and Winne did not address directly. The second reason was because both Boekaerts' and Winne and Hadwin's models were more complicated to understand, requiring solid theories and experiences of successful applications. Zimmerman has been cited most frequently. According to Moos and Ringdal (2012), investigation into the significance of instructors in fostering SRL in classrooms, Zimmerman's model currently dominated research in this area because of the "strong interpretive lens" it provided for determining the type of strategies that could be most helpful when working with teachers in the classroom suggested by these authors. This paper drew on Zimmerman's model of social cognition. The next section introduces the circle and the multi-level models of SRL (Zimmerman, 2000).

2.1.3. SRL Models Underlying the Social Cognitive Perspective

From the perspective of social cognition, the definition of SRL was different from that of traditional theories. It was not a single state, feature, or stage of existence. In contrast, the social cognitive view defined SRL as the periodic use of these steps to achieve goals according to a specific contextual process. This process required not only metacognitive knowledge but also emotional and action processes, plus self-efficacy. It has been described that the periodic interdependence of process, reaction, and beliefs in this process was broken down into three stages: forethought, performance or volitional control, and self-reflection. Moreover, the social cognitive view also emphasized the significance of teachers, parents, coaches, and peers when

developing self-regulation (Zimmerman, 2000). Therefore, some educators pointed out that the SRL of Zimmerman's social cognitive perspective was more appropriate for the classroom practice (Panadero, 2017; Spruce, 2012).

2.1.3.1. SRL Cyclical Model

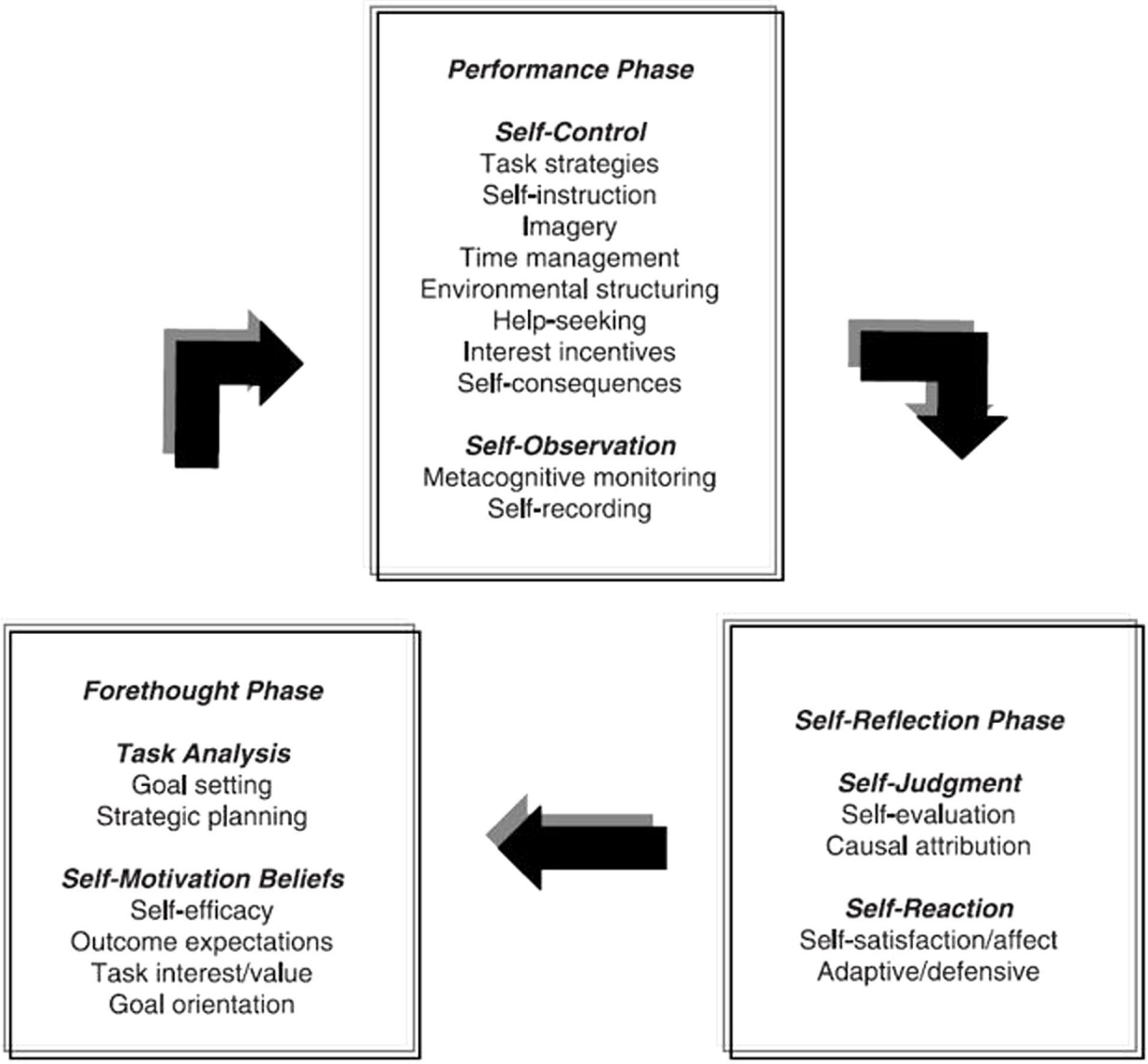
The SRL model of Zimmerman (2008) was employed in this study as its research framework. From the perspective of social cognition (Zimmerman, 2000), the process of SRL is a cyclical phase that focuses on forethought, performance, and self-reflection. This section analyzes each part of the cycle.

Forethought. In the stage of forethought, students assessed tasks, set goals, and made plans to achieve those goals. Some motivational beliefs stimulated these steps and made an impact on the execution of learning strategies. When achieving the process goal, it could become a kind of internal motivation, even more than the outcome goal. In the process of self-adjustment, they constantly adjusted their learning and task setting to achieve results.

Performance or volitional control. In the performance phase, learners monitored their progress and motivation through self-observation and feedback as they completed tasks. Learners could clearly explain the strategies and thinking processes they have chosen and recorded successful strategies and processes for future reference. Systematic self-observation could improve learners' understanding, performance, and control.

Self-reflection. The self-reflection phase occurred after some, or all the learning experience have been completed. This phase was about evaluating and assessing student performance based on the goals and strategies students have chosen at this point and the standards established in the self-reflection stage. Students were required to assess their performance to determine whether they succeeded or failed. These attributions caused self-reactions that positively or negatively impacted student performance on future tasks.

Figure 1 *Zimmerman's Cyclical Model of SRL*



Note. Taken from: Zimmerman, B. J. (2008). Investigating self-regulation and motivation: historical background, methodological developments, and future prospects. *American Educational Research Journal*, *45,* p. 178.

2.1.3.2. SRL Multilevel Model

By developing self-regulation capability, learners could be able to improve their performance in a classroom environment (Zimmerman & Kitsantas, 2005). The multilevel model developed by Zimmerman depicts the four stages. Students acquired the capability to self-regulate by taking them one by one (Zimmerman, 2000). These four stages were achieved through observation, emulation, self-control, and self-regulation stages. Student observation involved watching a model demo, listening to descriptions, and learning critical materials needed to apply the new skills. Emulation required that students were open and accepted feedback from others, corrected potential mistakes, and developed the skills necessary for success (Zimmerman & Kitsantas, 2002). Students emulated the presentation patterns of the model and incorporated them into their own projects as needed. In the self-control stage, students set process goals and monitored their performance independently. At this stage, students internalized their capabilities and achieved automaticity (Kolovelonis & Goudas, 2013). At the self-regulation stage, students acquired learning skills that they could apply and adapt to in different environments and changing situations. They were expected to make learning goals, to split further into sub-goals for processes and performance, and to use their outcomes to adjust the skills as needed (Puustinen & Pulkkinen, 2001). As a student mastered each of the four stages of training mode in turn, they were able to learn effectively. In contrast, it was not a developmental stage model

based on the assumption that students moved from one stage to another continuously or that was commonly used once students reached the highest stage (Kolovelonis & Goudas, 2013).

Figure 2 *The Multilevel Model of SRL*

Level	Name	Description
1	Observation	Vicarious induction of a skill from a proficient model
2	Emulation[a]	Imitative performance of the general pattern or style of a model's skill with social assistance
3	Self-control	Independent display of the model's skill under structured conditions
4	Self-regulation	Adaptive use of skill across changing personal and environmental conditions

Note. Taken from Zimmerman, B. J. (2000). Attaining self-regulation: A social cognitive perspective. In M. Boekaerts, P. R. Pintrich, & M. Zeidner (Eds.), *Handbook of self-regulation* (pp. 13–39). Academic Press.

2.1.4. SRL in Physical Education

An important target of education is to develop students' SRL skills, both in academic subjects as well as PE. Initially, research on SRL was conducted in the field of academic education, and later researchers turned their focus to the field of sports (Elferink-Gemser & Hettinga, 2017; Erikstad et al., 2018). In fact, researchers have found, that SRL strategies can also be beneficial in improving motor skills as well as performance (Kolovelonis & Goudas, 2012).

Researchers have primarily investigated self-regulation strategies aimed at motivation to learn, achievement goals, and student satisfaction. Several early research in the US has

documented how self-regulation strategies, including goal setting, self-talk, and self-recording, facilitated the achievement of higher levels of motor performance in students (Kolovelonis et al., 2012) and improved the level of daily physical activity (Shimon & Petlichkoff, 2009). For example, Zimmerman and Kitsantas (1997) analyzed the impact of introducing an SRL model on girls' dart throwing. The results showed that girl who set process goals and improved over time performed better, while girls who self-recorded and provided feedback were more likely to improve their performance in dart throwing. In addition, SRL strategies were found to improve the effectiveness of emotional learning, such as self-efficacy, satisfaction, and intrinsic motivation (Zimmerman & Kitsantas, 1997). When students set goals, they were more focused on the task, put more effort into it, were more persistent, and reported higher self-satisfaction (Zimmerman, 2008). In addition, process goals increased self-efficacy because the pursuit of explicit goals led to precise direction (Zimmerman & Schunk, 2001) and brought an immediate experience of self-satisfaction as students could see their progress in mastering new skills (Zimmerman & Schunk, 2004).

Zimmerman summarized his summary of empirical evidence in his career report (Zimmerman, 2013). His empirical research not only focused on academic skills, but also made excellent contributions to athletic skills. Zimmerman's multilevel and cyclical models have been extensively tested for use (Puustinen & Pulkkinen, 2001; Zimmerman, 2013). Zimmerman, Kitsantas, and Cleary collaborated to test multilevel models (Kitsantas et al., 2000; Zimmerman & Kitsantas, 1997).

Zimmerman and colleagues have conducted two studies with results that supported the validity of a multilevel training model for SRL development. Firstly, the early research by Zimmerman and Kitsantas (1997) assessed the transition from Stage 3 self-control to Stage 4 self-regulation. A total of eight experimental conditions were applied and four types of goals were assigned to the students: first, a performance goal to achieve a high dart score. Second, process goals to improve darting techniques. Third, convert dart scores into transformational goals for strategic process adaptation. Fourth, move from process goals to performance goals. Participants were asked to keep a self-log during the training. According to the results, participants who first defined process goals and then outcome goals performed better in darting and expressed the highest levels of self-efficacy, satisfaction, and intrinsic interest in comparison to participants in the other goal-setting conditions. In terms of achievement, self-efficacy, and satisfaction, self-recording had the potential to be beneficial. In addition, students who set process goals achieved higher results in PE instruction than their counterparts who set performance goals (Kitsantas & Zimmerman, 1998; Zimmerman & Kitsantas, 1996). In addition, Kitsantas et al. (2000) studied ninth-grade girls' dart throwing by studying their observation and imitation levels. Finding showed that girls who observed their performance improving over time achieved better results, had a greater sense of self-efficacy, intrinsic motivation, and satisfaction, as compared to girls who observed their performance degrading over time.

In his review of the SRL model, Panadero (2017) summarized several tests conducted using Zimmerman's cyclical model. First, Cleary et al. (2006) examined adolescent boys in terms of

their SRL skills. The subjects included basketball experts, non-experts, and novices. They found that specialists were better at performing the SRL. Second, Zimmerman and Kitsantas (2002) compared volleyball experts and non-experts among female students and found that SRL skills projected 90% of the difference in serving skills. Third, Cleary et al. (2006) tested 50 college students under five different conditions. The results showed that the more practice sessions the participants completed, the higher their scores were in relation to them. Fourth, educators completed the research with 51 high school students in science classes and found that the upper grades showed greater use of the subprocesses in Zimmerman's model (DiBenedetto & Zimmerman, 2010).

2.1.4.1. Using Goal Setting to Guide Students' Lessons

Setting goals was an important part in SRL (Kitsantas et al., 2018; Kolovelonis & Goudas, 2013; Zimmerman & Kitsantas, 2005). The students adopted the teacher's model of performance standards at the observation and emulation level, where they adopted the process goal. In contrast, the social cognitive training model assumed that the introduction of goal setting occurs at the level of self-control. To examine the effects of introducing imitation-level goals, Kolovelonis and Goudas (2013) replicated and extended the study of Kolovelonis et al. (2012). The results showed that students' dribbling performance in basketball practice improved from pretest to posttest when they set process and outcome goals for self-directed practice at the

emulation and self-control levels. Therefore, Kolovelonis and Goudas (2013) proved that goal setting at the emulation level was as effective as goal setting at the self-control level.

Moreover, both performance goals and process goals could be positively associated with student performance (Kolovelonis, Goudas, & Gerodimos, 2011). However, as a learning strategy, students should focus on the process goals at the beginning of their efforts to master a skill (Kitsantas & Zimmerman, 1998; Kolovelonis & Goudas, 2013; Zimmerman & Kitsantas, 1996). Students could focus on improving their own performance after mastering the basic elements of skills by setting their own outcome goals for personal improvement after learning the basic elements of skills (Zimmerman & Kitsantas, 1997). For SRL development, this was considered to be an important change in goals and was even more important in PE programs (Kolovelonis et al., 2010).

A report by Kitsantas et al. (2018) detailed how PE teachers participating in their experiment incorporated practices of self-regulation into their teaching. For example, the students who took PE courses were supposed to focus on the basic movement (the elements that make up each exercise) as well as on the performance goals (the number of attempts that were technically correct) when they practiced the exercises. It was encouraged for students to set process and performance goals over a longer period of time based on their individual needs, such as over an entire month. The purpose of goals was to give learners direction by focusing their attention on the basic elements of skills in order to master new tasks (Zimmerman, 2008). Therefore, the effective goal setting could be divided into two parts. At the beginning, teachers could guide

students in setting specific, clear, challenging, and personal goals (Kitsantas et al., 2018). A second step was for students to design a plan as to how they would realize their aims and then monitored their achievements (Goudas & Kolovelonis, 2013). Students who followed the steps outlined above were more likely to reach their final goals and were more motivated to succeed because they gained more self-confidence and focus during the process (Schunk & Usher, 2012).

2.1.4.2. Value of Self-monitoring and Self-recording in Physical Classes

Self-regulated students generated feedback in regard to their learning and performance internally and applied the feedback for monitoring and regulating their studying and performance (Kitsantas et al., 2018). For self-monitoring, this was possible through metacognitive monitoring as well as self-recording. In the context of metacognition and self-monitoring, metacognition was referred to as the investigation and evaluation of one's performance and outcomes, while self-recording included a record of the learning process or outcomes to help students take notes on their performance as they happened (Zimmerman & Kitsantas, 2005).

It was critical to apply self-review tasks to promote SRL (Kitsantas et al., 2018). First, self-review was a belief that motivated students to learn. Second, self-recording helped students monitor their study effectively. Third, self-examination was used to promote self-assessment. When students determined whether they had achieved their goals, they linked the three phases of SRL: self-efficacy and task value (the planning phase), self-recording (the performance phase), and assessing if students had achieved the goals (the self-reflection phase) (Zimmerman, 2000).

Self-recording was shown to positively affect student achievements in several empirical studies (Cleary et al., 2006; Kitsantas & Zimmerman, 1998; Kolovelonis, Goudas, & Dermitzaki, 2011; Kolovelonis, Goudas, & Gerodimos, 2011; Zimmerman & Kitsantas, 1996). Kitsantas et al. (2018) also reported this view in their study. For instance, students were asked to record the main technical points of each exercise and the number of correct repetitions during the exercise itself. The results showed that students who used self-recording mastered the motor skills faster than those who did not.

Goudas and Kolovelonis (2013) pointed out that from a practical point of view, self-recording was better when limited to a few items at a time. Also, task lists and recordings were recommended to be concise and focused. First, practicing and recording once provided more accurate information. Second, simple exercises were easier to motivate students and to make them feel interested in learning.

2.1.4.3. Importance of Self-reflection

Self-regulated learners were expected to self-reflect on their learning efforts and performance, and to adjust their position in the SRL circle accordingly (Kitsantas et al., 2018). In PE, learners evaluated their training plans using appropriate goal setting and self-referenced assessment criteria. Research has shown that self-assessment positively affected students' skill acquisition (Kitsantas et al., 2004). Research conducted by Kitsantas and Zimmerman (2006)

found that grading student self-assessment measures as opposed to absolute measures was more effective at improving student performance and satisfaction with performance.

In addition, self-reflection questions encouraged students to think about themselves and engage in discussions about attribution types and ways to improve performance (Kitsantas et al., 2018), which helped them use the same strategies in subsequent learning and performance or modify them as needed, adjusting the incorrect or underperforming parts (Zimmerman & Kitsantas, 1999). Kitsantas et al. (2018) also mentioned that PE teachers asked students to self-reflect on their physical activity and health by keeping a diary and relied on the feedback to adjust their learning. In addition, teachers provided feedback during practice sessions, prompted students' self-reflection on their performance, and helped them plan further learning, so that students obtained the skills to learn.

2.1.5. Zimmerman Model with Performance Phase Enhancement in Physical Education

Zimmerman's cyclical model is widely used in academic classrooms and is approved for its positive impact, as it helps students perform better and become more motivated. The multilevel training model of self-regulation (Zimmerman, 2000) works well when promoting self-regulation in the PE classrooms. This model indicated that mastering a sport usually start from observing, and then instructing verbally and demonstrating practically by teachers. Next, students receive feedback from their PE teacher or peers to practice the skill. Feedback may have included positive feedback on performance and exhortations to perform appropriately. However, as

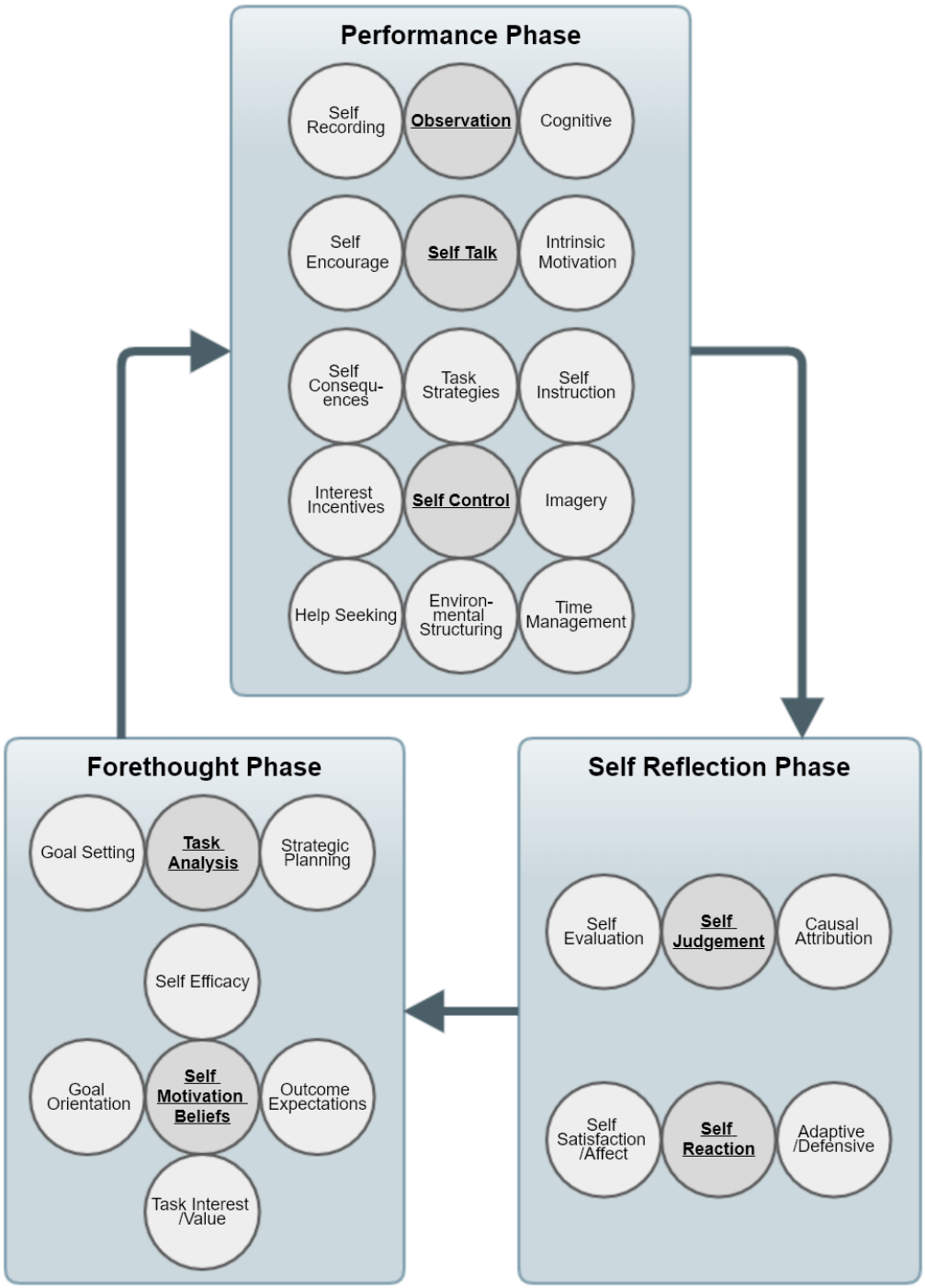
students master the skill, teacher feedback are gradually reduced and replaced with self-feedback. Students self-directed their practice, set goals, self-monitored their performance, and used self-recording skills, consistent with Zimmerman's SRL cycle model (Kolovelonis & Goudas, 2013). Thus, when students mastered a skill, they return to the self-regulated models. Zimmerman's existing SRL model emphasized motivation, cognition, and metacognition. However, the original model needs to be supplemented to be more appropriate for PE teaching in order to be more effective.

Self-talk is a concept from psychology that has since been applied to sports. Zourbanos (2013) explained the definition of self-talk in the context of sports, which means talking to oneself as an internal dialog that individuals used to explain their thoughts and feelings, adjust and modify their assessments and perceptions, and provide themselves with orders and reinforcements regarding sports training and performance. In the understanding of Theodorakis et al. (2000), self-talk refers to mean that whenever individuals think about something, they are in some way talking to themselves. It can be speaking out loudly or saying quietly in one's mind. Studies on self-talk are extensively reviewed by sport researchers and provided compelling evidence in terms of how effective self-talk interventions could be in sports settings. A recent study in the area of sports showed self-talk could be very helpful for students to acquire new motor skills and conduct self-regulation in reality, for the purposes of improving performance and facilitating studying (Marjanovic et al., 2020). Previous studies showed that self-talk had significant effects on improving students' athletic performance (Kolovelonis, Goudas, &

Gerodimos, 2011; Zourbanos et al., 2014), stimulating sports motivation (Hatzigeorgiadis, 2006), and improving their self-confidence (Ada et al., 2019; Kolovelonis, Goudas, & Dermitzaki, 2011).

Kolovelonis et al. (2012) explored the impact of self-dialog in terms of how it improved students' performance in goal-oriented sports exercises. They found that the students with self-talk connected with various targets in terms of processes and achievements learned more effectively and efficiently, compared to their peers in the control group. Kolovelonis, Goudas and Dermitzaki (2011) confirmed the better performance by the students in two PE class tests if they applied self-dialog. Therefore, Kolovelonis and colleagues suggested that self-talk could improve student sport achievements and potentially played an important role in Zimmerman's social cognitive model of SRL (Kolovelonis & Goudas, 2013). Therefore, this study would place self-talk in the performance phase to enhance the SRL learning cycle in Zimmerman's model because self-talk was better suited to improve task performance and skill acquisition in PE class (Zourbanos, 2013).

Figure 3 *Zimmerman Model with Performance Phase Enhancement*



2.1.6. Comparison Against Other Types of Learning

In 1989, Zimmerman introduced the idea that there was a causal relationship between individual, behavioral, and environmental effects on self-regulated learning strategies on SRL (Zimmerman, 1989). Although Zimmerman included reciprocity in the form of other sources of regulation from the environment, such as guidance, environment, and peers, he still referred to reciprocity as an aspect of the self (Andrade et al., 2021). Zimmerman's article was groundbreaking in that it considered social cognitive processes and included reciprocity, but its reference to learning still revolved around the self. Many current studies indicate that the main body of learning lay in the students themselves (Adie et al., 2018; Andrade & Brookhart, 2020). These developments reflected cognitive and constructivist learning theories that emphasized the importance of student agency as self-regulation of learning (Pintrich & Zusho, 2002; Zimmerman & Schunk, 2001).

In contrast, Dann (2014) applied the socio-cultural theory of learning, which recognized the significance of teachers and peers in helping learners understand the gap between where they were and where they needed to be. For instance, Allal (2020) argued that learners in the classroom environment only partially separated themselves from peer and external regulation and did not reach a completely autonomous state of self-regulation. Instead, they learned to engage in increasingly complex and varied forms of shared regulation. Therefore, co-regulation and external regulation were two important factors that needed to be focused on.

PE is considered a multidimensional discipline (Graham, 2008) that involved various aspects such as skills, tactics, health, and society. In sports learning, the cooperation between teachers, classmates, and oneself was regarded as crucial. Therefore, co-regulation and external regulation might be equally applicable to the PE classroom. Coaches and teachers were considered professionals who guided students in learning and practice, provided knowledge about skills and tactics, helped students improve their abilities, and provided support (Haerens et al., 2013). Peer interaction was also seen as a means to improve the sense of cooperation and community among students, which was especially significant for team sports (Fernandez-Rio & Casey, 2021; Leisterer & Jekauc, 2019).

2.1.6.1. Co-Regulated Learning

Co-regulated learning refers to the social regulation of learning in which learners worked with other students or teachers to temporarily regulate their cognition, behavior, motivation, and emotions (Hadwin & Oshige, 2011; Järvelä & Järvenoja, 2011). Co-regulated learning is a collaborative process in which learners worked with others (such as teachers, peers, or parents) to achieve learning goals and improve learning strategies (Butler & Winne, 1995; Zimmerman & Schunk, 2001). In co-regulated learning, learners receive guidance and support from others and actively participated in regulating their own learning. This type of learning emphasized the importance of social interaction in the learning process and the role of individual agency and self-regulation (Butler et al., 2013). This increased engagement, motivation and achievement as

learners are able to benefit from the expertize and perspectives of their peers. It involves sharing goals, feedback, and resources, as well as providing mutual support, encouragement and guidance (Järvenoja & Järvelä, 2009). Co-regulated learning also provide learners with the opportunity to develop social and emotional skills, such as communication, collaboration, and empathy.

Co-regulated learning has been extensively studied in the field of educational psychology and was found to be effective in promoting learning outcomes, especially in complex and challenging tasks (Dignath & Büttner, 2008; Zimmerman & Moylan, 2009). Co-regulated learning took many different forms, including peer tutoring, collaborative learning, and teacher-student interaction. It could be applied in a variety of environments, from traditional classrooms to online learning environments (Zimmerman, 2013).

Co-regulated learning could be applied to PE to promote skill development, teamwork, and positive social interaction. In the PE environment, co-regulated learning involved collaboration between students, teachers, and peers to support each other's learning and progress. Research showed that the use of co-regulated learning strategies in PE enhanced student engagement, motivation, and learning outcomes (Reeve & Tseng, 2011). For example, Rivera-Pérez et al. (2021) investigated the effects of co-regulated learning on physical activity in PE classes. The study found that the use of cooperative learning strategies, such as setting goals, self-reflection, and peer feedback, led to increased physical activity levels among students. The researchers also reported that co-regulated learning strategies helped to create a positive and supportive learning

environment. Similarly, Cheon et al. (2012) examined the impact of co-regulated learning on middle school students' motivation in a PE setting. It was found that cooperative strategies, such as cooperative goal setting and peer support, could enhance students' learning motivation and improve learning outcomes. In addition, a study by Cecchini Estrada et al. (2019) explored the influence of co-moderating learning on the development of social skills in sports. The researchers found that peer tutoring and cooperative learning strategies would promote the development of students' social skills and positive relationships. Overall, these studies suggested that co-regulated learning was a practical and effective way to increase student engagement, motivation, and learning outcomes in PE classes.

2.1.6.2. Externally Regulated Learning

External regulation refers to the situation in which students relied on the guidance and control of teachers (or textbooks, classmates) to regulate the learning process (de la Fuente et al., 2020). In this model, teachers assumed the supervision activities of students, and students relied on external guidance to construct their learning experience and monitor their progress (Müller & Seufert, 2018). This includes setting goals, determining learning strategies, receiving feedback, and self-reflection. In this type of learning, students are largely passive, relying on external cues, prompts, or feedback to guide their learning.

Although externally regulated learning could be effective in certain situations, such as when the learner was new to a subject or needed explicit guidance to acquire basic skills, it had certain

limitations. It might not have promoted deep or meaningful learning because the learner might not have actively participated in the learning process or have had the motivation to learn. In addition, learners might have over-relied on external cues or feedback, and might have had difficulty transferring their learning to new or more complex situations (Pachón Basallo et al., 2022). Overall, externally regulated learning could have been a useful tool in some situations, but it should have been balanced with the opportunity for learners to take more control of their own learning and develop internal regulated skills (de la Fuente-Arias, 2017; Lindblom-Ylänne et al., 2011).

The external adjustment in PE teaching refers to the use of external factors to guide and direct the learning process in PE teaching. This includes using external prompts, feedback, and guidance provide by teachers or coaches to help students develop and improve their motor skills, physical fitness, and overall understanding of sports (Laxdal et al., 2019). In PE, external supervision could have taken many forms, such as demonstration, oral instruction, visual aids, and performance feedback (Kolovelonis & Goudas, 2013). For example, teachers could have demonstrated appropriate techniques for specific movements or skills and provided feedback on student performance to help them make adjustments and improve their form (Laxdal et al., 2019). External adjustment in PE teaching could have helped students understand sports and physical activity more comprehensively. It could have also helped improve safety and reduce the risk of injury during physical activity (Laxdal et al., 2019; McBride, 2017).

The study conducted by de la Fuente et al. (2020) aimed to investigate the impact of intrinsic and interpersonal factors on college students' learning methods, academic achievement, and satisfaction. The findings indicated that a combination of self-regulation and external regulation could be ordered on a five-point scale or at the level of heuristics. Furthermore, Theory of Self- vs. Externally Regulated Learning (de la Fuente-Arias, 2017) highlighted that external regulation in education did not mean external control over students. Instead, external regulatory actions were designed to facilitate and assist students in developing their internal self-regulation skills. The goal of external regulation was to help students acquire the skills and strategies required to become more effective self-regulated learners. This approach recognized that students might require some external guidance and support to develop their internal self-regulation (Laxdal et al., 2019; McBride, 2017). By providing targeted feedback, guidance, and support to students, teachers and other education professionals could help students become more confident and effective learners. Overall, the aim of external regulation was to promote the development of students as self-regulated learners.

In addition, some studies have proposed that external feedback from teachers, teaching assistants, peers or systems could be provided to students during the reflective stage of student SRL to promote better SRL behavior and performance (Azevedo et al., 2008; Chou & Zou, 2020; Lin et al., 2021; Panadero et al., 2019; Shyr & Chen, 2018). In general, external feedback was designed to facilitate student supervision, provided students with information about their learning (i.e., externally observable outcome performance). That was, external feedback served as a

scaffold or external support to assist students in monitoring and reflecting on whether there was a discrepancy between their current performance and their expected performance goals (Nicol & Macfarlane‐Dick, 2006). In this way, students could self-regulate their learning to reduce any such discrepancies (Chou & Zou, 2020).

In summary, most systems for training SRL behavior focused on providing a learner-centered environment. Based on the literature, external braces were more promising for effective SRL training. Peer assistance and teacher assistance were used as external scaffolding in the process of training SRL behavior, increasing opportunities for self-reflection as well as motivating and encouraging learners (Lin et al., 2016). Therefore, on top of the above analysis about co-regulated learning and externally regulated learning, learning strategies should be according to individual needs, abilities, and conditions was a better way to help PE students to develop a variety of learning skills (Laxdal et al., 2019; Lindblom-Ylänne et al., 2011; McBride, 2017).

2.2. Teachers' Beliefs

2.2.1. Definition of Teachers' Beliefs

Belief is a subjective cognitive experience (Pehkonen & Pietilä, 2003) and is usually defined as a judgment based on personal experience (Raymond, 1997). Teachers' beliefs could be described as personal structures, which enables teachers to understand, judge, and evaluate their

practice (Pajares, 1992). Levin et al. (2013) mentioned that teachers had many different beliefs at the same time. They had beliefs about various things. Some were about knowledge (i.e., epistemology), some were related to their students (i.e., attribution, motivation, test anxiety), and the rest could be regarding other factors (i.e., self-efficacy, self-worth, self-concept). Teachers also had beliefs about how they teach, what they teach, and about many social issues. Pajares (1992) noted several keywords about teachers' beliefs that usually appeared together in papers: attitude, value, judgment, axiom, opinion, mission statement, ideology, perception, concept, conceptual system, personality, implicit theory, explicit theory, personal theory, personal practice knowledge, and perspective.

In the 1980s, researchers studied teachers' beliefs in terms of what they referred to as their practice knowledge (Elbaz, 1981) and their practice theory (Fenstermacher, 1986) as well as in terms of the connection with teachers' behavior (Clandinin, 1986). Across disciplines, researchers have coined a variety of terms describing similar interactions between knowledge, beliefs, and practices. Teachers' beliefs have been studied using such terms as personal practical theory (Clandinin, 1986), practical rationale and practical argumentation (Fenstermacher, 1986), practical knowledge (Sanders & McCutcheon, 1986), practical concept (Goodman, 1988), and personal practice philosophy (Cornett, 1990).

In the 1990s, Pajares (1992), Richardson (1996) and Calderhead (1996) clarified that knowledge was different from beliefs, stating that individual thinking was the foundation of beliefs. On the other hand, facts accepted by others in the community became ones' knowledge.

Teacher beliefs could be categorized into five categories by Calderhead (1996, p. 716): "beliefs about learners and learning, beliefs about teaching, beliefs about curriculum, beliefs about teaching and learning, and beliefs about self and teaching". The five categories were interrelated with and influenced by each other. Teachers' beliefs contain subjective and objective elements and are influential factors when teachers make decisions and teach in classrooms (Richards & Lockhart, 1994).

More and more studies suggested that teachers' beliefs were closely related to teachers' knowledge, especially practical knowledge, which determines teachers' behavior (Levin, 2015). The consensus among scientists is that beliefs were usually instinctive and personal, reflecting individual judgments as well as interpretations of community consensus knowledge (Lundeberg & Levin, 2003; Richardson, 1996). Fives and Buehl (2012) confirmed that the beliefs of teachers in teaching, epistemology and self-efficacy help form a system and a filter of beliefs to explain their experiences, as well as a framework for solving problems they encounter, and a guide for their actions. In addition, in the research papers on the development of teacher professional identities, it was demonstrated that teachers' beliefs could be impacted by the teachers' background and career experiences related to societies, culture, politics, and history (Fairbanks et al., 2009; Meijer et al., 2001). Finally, researchers also discussed the representation of teachers' beliefs in a comprehensive system that is critical to perception, interpretation, and prediction (Churchland, 2013; Fives & Buehl, 2012). Vosniadou et al. (2020) defined teachers' beliefs system as an evolutionary structure that encompassed knowledge domains. This beliefs system

was shaped by the teachers' background and was used to interpret the information they receive. Gilakjani and Sabouri (2017) also explained this view. They believe that teachers' beliefs system was formed as they gain professional experience and knowledge, thus influencing their understanding, judgment, and behavior.

2.2.2. Teachers' Beliefs Regarding SRL

Several studies have addressed SRL from different theoretical perspectives, and scholars generally achieved the agreement on the higher likelihood for students to achieve satisfactory grades after they used effective regulation strategies to guide themselves in learning (Boekaerts, 1999; Pintrich, 2000; Zimmerman, 2008). There has been evidence that students who used the SRL strategies have improved their academic performance (Dignath & Büttner, 2008; Schunk, 2018; Spruce & Bol, 2015). However, most teachers did not give clear and straight-forward guidance to develop students' self-regulation in the classroom (Dignath, 2016; Griffin et al., 2012; Kistner et al., 2010; Spruce & Bol, 2015). As shown in the studies, it was possible that teachers' beliefs could be in conflict with SRL theory resulted in a fact that SRL strategies were rarely taught in their class (Darmawan et al., 2020; Vosniadou et al., 2020). Therefore, following section reviews the teachers' beliefs about inconsistency and consistency with SRL theory.

2.2.2.1. Inconsistent Beliefs of SRL about Learning and Teaching

A commonly seen SRL-inconsistent sense was that teaching was only about transferring knowledge and experience in a teacher-centered environment (Vosniadou et al., 2020). Ambrose et al. (2010) showed that it was difficult for teachers before entering the service to believe that their primary responsibility was to develop students' learning habits and strategies. Because there was a general attitude among teachers that it should be their job to transmit factual information about the subject matter to the students. Although student-centered orientation class has been widely proposed, it was hard to change their mind. Mostly, pre-service teachers strongly believed that teaching was a process of transmitting knowledge, and that teachers were tasked with transmitting knowledge to their students (Kramarski & Michalsky, 2010; Zohar, 2004). It should be noted that SRL theory de-emphasized the teachers' role to transfer knowledge in classrooms and emphasized the significance of strategies of teaching. It was not just provided exiting knowledge and construction concepts (Perry et al., 2015).

Second, there were other beliefs that challenge the concept of teaching SRL strategies, such as the idea that learning happens quickly and that learning was an innate talent that could not be taught (Dignath, 2016) and the belief that it was a subject that could be described as difficult. If pre-service teachers' assumptions about learning were that it was an innate capability that was not possible to be changed, they did not tend to endorse or support SRL theories, in which

students were able to learn how to use the right strategy to improve their performance and make learning more efficient in the process (Darmawan et al., 2020).

2.2.2.2. Consistent Beliefs of SRL about Learning and Teaching

The teachers' beliefs in SRL refers to SRL is necessary and appropriate strategies for students. More specifically, they were perceived as agents who were actively engaged in the process, which entailed interpreting the information they receive and creating meaning for it to fit what they already knew. The most important thing in learning was that students derived meaning from the information they were exposed to. It was worth considering from this viewpoint that teachers were more effectively able to help their students deal with study trouble if they helped students to hold learning strategies rather than just teaching knowledge about the subject (Darmawan et al., 2020; Dignath, 2016; Perry et al., 2015; Vosniadou et al., 2020). There have been few studies specifically examining whether teachers believed in that SRL learning strategies could help students enhance their academic performance, but numerous attempts have been made to measure students' and teachers' perceptions of SRL (Dignath-van Ewijk & van der Werf, 2012; Lombaerts et al., 2009; Spruce & Bol, 2015).

Dignath-van Ewijk and van der Werf (2012) found that the factors of teachers' beliefs had an impact on both cognitive and behavioral aspects of their practice of SRL in teaching. The study involved 47 teachers from primary schools in the Netherlands in the research. They answered an open question about their intention to promote SRL in the classroom by completing

a questionnaire about their SRL beliefs. In school contexts, the teacher's answers indicated that many of them supported constructivism and SRL in primary schools, and that most of the teachers associated SRL with promoting student independence by providing a collaborative and positive learning environment. In conjunction with the research findings that facilitated the observation of SRL in their class, teachers actually made learning environments that enabled students to engage in SRL.

In the research from Lombaerts et al. (2009), it surveyed 172 elementary school teachers and explored whether the cognitive elements of elementary school teachers' attitudes towards SRL influences specific aspects of their students' implementation of SRL. Researchers evaluated how much teachers agreed on SRL, and they were satisfied about their personal conditions in the school could be predicted by their willingness to implement SRL.

Spruce and Bol (2015) assessed how teachers' SRL beliefs were associated with SRL knowledge among ten teachers in primary schools and secondary schools. The focus was on how teachers promoted students' SRL practice in the classroom. Based on the Zimmerman SRL model, the authors developed their methods and results. The authors administered questionnaires, observed lessons, and interviewed teachers to construct their study. The results indicated that teachers gave positive beliefs about the SRL implemented in classrooms. Even though a few teachers had very limited knowledge of SRL, their beliefs about its effectiveness in teaching were positive.

2.2.2.3. Development of Teachers' Beliefs SRL Scale

In many studies, teachers' beliefs were considered to be critical for promoting and inhibiting changes in classroom practices and innovation (Lawson et al., 2019; Lombaerts et al., 2009; Pajares, 1992; Warfield et al., 2005). Consequently, several instruments were invented for determining how much teachers believe in SRL (Endedijk & Vermunt, 2013; Hermans et al., 2008; Michalski, 2013). There were two among them, which were the most relevant to the purpose of this research, i.e., Self-regulating Learning Teacher Beliefs Scale (SRLTB) by Lombaerts et al. (2009) and Beliefs About Learning and Teaching 3 (BALT3) by Darmawan et al. (2020).

Specifically, the SRLTB scale had 10 items which was intended to assess teachers' beliefs about how SRL could be implemented in the elementary school. There were several statements on the questionnaire regarding the possibility that students had to make choices in the classroom, such as the second question: "Pupils should be able to make decisions about the sequence and duration of their learning activities more often." Other statements targeted to understand if teachers believed that enabling students to self-regulate in the classroom was an advantage, such as the eighth question: "Self-regulated learning provides pupils with a more thorough preparation for their transition to secondary education." Furthermore, teachers were asked in a more general context to provide comments about their views on self-regulation and students, such as the sixth question: "Every student should have the opportunity to self-regulate their learning." As a result,

teachers with higher scores were treated as supporters of SRL. Lombaerts et al. (2009) emphasized that the SRLTB scale was useful to assess the degree of teachers' SRL beliefs in the context of teaching practices in elementary schools.

Another scale was BALT 3 (Darmawan et al., 2020). It took three phases to develop the BALT questionnaires. The first version was called BALT1, which had an obvious shortcoming that it examined two factors inconsistency beliefs with SRL, i.e., Transmissive Teaching (TranT), and Quick and Natural Learning (NatL). BALT1 worked well and produced good results that encourage the researchers to enhance it. As a result, a new version was developed and called BALT2. It included new items for testing the quickness and naturalness of learning and two other factors. One teaches a kind of beliefs that a person's learning could not be controlled by himself. The other one believed that the learning strategies commonly suggested by SRL were not necessary or important in learning processes. Subsequently, the author and his colleagues developed BALT3, which was more balanced because it contains items that represent consistent and inconsistent beliefs with SRL. BALT3 has 58 projects with 7 factors in total, i.e., Nature of Constructive Learning (ConL), Quick and Natural Learning (NatL), Constructive Teaching (ConT), Transmissive Teaching (TranT), SRL Achieve (SRLAc), SRL Negative (SRLNeg), and Locus of Learning Control (LoLC).

Based on the results of studies using the SRLTB, researchers have found that teachers' beliefs were significantly influenced by practices when self-assessment was used (Dignath, 2016; Lombaerts et al., 2009). Darmawan et al. (2020)' study showed that this might not always be true

when teachers' SRL practices were assessed by classroom observation. For instance, Spruce and Bol (2015) demonstrated the limited experience of 10 teacher interviewees in using SRL in the classroom, even though most of them though positively regarding SRL. There were several explanations for the difference between what teachers said and what they actually did. Darmawan et al. (2020) gave two reasons for this explanation. The reason could be that SRLTB was a function of social desirability. Thus, it made sense that teachers tend to agree with SRL statements based on social concerns. A second explanation could be the focus of the present study. Teachers might have beliefs that were consistent and inconsistent with SRL at the same time. But SRLTB could not accommodate both types of beliefs. Some teachers with inconsistent beliefs were not aware that there was a contradiction between those beliefs and the way they conducted their practice. This lack of awareness of SRL requirements was revealed by Spruce and Bol (2015), who reported that many teachers were surprised because of their low-level grade of SRL in assessments. BALT3 supplemented the SRLTB scale, thus assessing teachers' SRL beliefs more extensively.

2.2.3. Teachers' Beliefs in Physical Education

The literature showed that implicit theories held by novice, inexperienced, and experienced teachers influence their responses to teacher education and teaching practice (Green, 2002). A multitude of judgments and decisions were influenced by beliefs, which acted as a filter through which selections were made (Pajares, 1992). The beliefs of PE teachers were at the heart of their

professional development, having a lasting impact on their careers (Philpot & Smith, 2011). Green (2002) focused more directly on how belief systems could relate to sports. Its results indicated that PE teachers had rich experience in collective and individual sports and the experience strongly influences their beliefs. However, when they entered the PE classroom, the new teaching concepts and their past experiences as athletes were blended together to form their own beliefs.

Philpot and Smith (2011) examined students' different perceptions of the nature and purpose of PE instruction at the beginning and during their studies. As part of a case study, they interviewed 12 PE students at a college in New Zealand. The results suggested that students graduated with a deeper understanding of PE and the complexity of professional training. The study revealed four themes: sports as activities rather than exercise, importance of biophysical science, health and sport and studies of uncertainty and complexity. If teachers had a different understanding of PE, their view of PE was also changed.

As a matter of fact, it was widely acknowledged that exploring the role of beliefs in teaching was crucial. Teachers' beliefs about their work and areas of expertize influence their views, judgments, and teaching practices (Tsangaridou, 2008). Therefore, understanding individual belief structures was critical to optimizing teacher education programs and instructional practices in schools (Philpot & Smith, 2011).

2.3. Teachers' Knowledge

2.3.1. Definition of Teachers' Knowledge

Teacher knowledge refers to all the knowledge mastered by teachers at a given moment, which is the basis for guiding teachers' behavior (Carter, 1990). In previous literature on teacher knowledge, researchers have used various terms to describe teacher knowledge: personal knowledge (Connelly & Clandinin, 1985; Elbaz, 1991); the wisdom of practice (Schwab, 1971); action-oriented knowledge (Carter, 1990); content-based and context-based knowledge (Cochran et al., 1993; van Driel et al., 1998); and knowledge from reflective experience (Grimmett & Mackinnon, 1992; Gunstone, 1999), with each term illustrating what the author considered important.

According to Verloop et al. (2001), "knowledge" has been recognized as an overarching conceptual framework that guides the interpretation of a plurality of cognitions, from conscious, balanced perspective to unconscious, unreflective intuition (Verloop et al., 2001). This was due to the fact that the teachers' mind and knowledge were inextricably linked, and he or she always experiences them together using knowledge as the springboard for the next learning process. As Alexander et al. (1991) noted, "the term knowledge was primarily used to encompass everything that one knows or believes to be true, whether it has been proved true in some objective or external way" (p. 317). In particular, it was related to the development of teaching knowledge research. When investigating teacher knowledge, the research focused on cognition, cognitive

development, and the interaction between cognition and teaching activities. According to (Pajares, 1992), knowledge and beliefs were believed to be indivisible, even though the former was generally understood to refer to individual values, attitudes, and ideologies, whereas the latter was the propositions for teachers themselves (Meijer et al., 2001).

At the beginning of the 20th century, following the content of the examination for the teachers' diploma, it was pointed out that teacher knowledge had two levels. One referred to the knowledge about what should be taught to students. The other meant the knowledge of the teaching contents. Since the middle of the 20th century, well organized studies have been conducted on teaching and the research area has shifted to a variety of teacher characteristics and behaviors associated with higher student achievement. In 1980, educators focused on systematizing basic knowledge, which was particularly reflected in content knowledge (Shulman, 1986). Historically speaking, it was a common practice to define teacher knowledge a framework, covering a general understanding of teaching principles and standards, and the subject content being taught (Grossman & Richert, 1988). As a consequence, early studies of teacher knowledge were limited to the central place of teachers when teaching certain subjects as well as when employing the appropriate techniques, rules, and principles to do so.

Over time, the notion of teacher knowledge has expanded and broadened considerably. In the 1990s, researchers pointed out the complexity of teacher knowledge (Edwards & Ogden, 1998; Tamir, 1991). Research has demonstrated that teacher knowledge stems from three different types of sources: professional knowledge, general knowledge, and knowledge relating

to personal traits (Tamir, 1991). They argued that the personal practical knowledge teachers develop over time in different settings was crucial to ensure that students master the subject. Nowadays, teachers were required to have higher level knowledge. As described by researchers, teacher knowledge might be treated as a pluralistic system, covering personal domains, knowledge, beliefs, and attitudes of teachers (Clarke & Hollingsworth, 2002; Gorski, 2009).

Therefore, to summarize the development process of knowledge, the profession of teaching encompassed several different areas and types of knowledge. All teachers had some of these characteristics in common, (i.e., knowledge of student development or forms of assessment), while others vary by subject (i.e., mathematics, languages, PE, or history), age group, or educational background of the teacher (i.e., knowledge of child development or forms of assessment). Shulman (1986) proposed one or more types of teacher knowledge: content knowledge, general pedagogical knowledge, curriculum knowledge, pedagogical content knowledge, knowledge of learners and their characteristics, educational background knowledge, educational purpose knowledge, and values and their philosophical and historical basis. Among them, three categories were particularly influential for further research (Dignath-van Ewijk & van der Werf, 2012):

- General pedagogical knowledge (principles and strategies for classroom management and organization across courses)
- Content knowledge (knowledge of topics and their organizational structure)

- Pedagogical content Knowledge ((knowledge of content and pedagogy)

2.3.1.1. General Pedagogical Knowledge

The term pedagogical knowledge denoted the knowledge associated with teaching and learning. An essential component of this domain is classroom management knowledge, such as how to engage groups of students in various classroom tasks. The literature review showed that almost all countries consider the following two as teachers' core tasks: teaching and managing in the classroom (König & Kramer, 2016). As a result, there were a number of aspects of general pedagogical knowledge that could be defined as being part of general pedagogical knowledge, such as pedagogical concepts as well as learning theories and methods.

As discussed in Shulman (1987), general pedagogical knowledge included "broad principles and strategies for classroom management and organization that seem to extend beyond the subject, as well as knowledge about learners and learning, assessment, educational context, and purpose" (p. 8). At the same time, Grossman and Richert (1988) extend this definition by explaining that general pedagogical knowledge included "knowledge of learning theories and general pedagogical principles, understanding of various educational philosophies, general knowledge of learners, and knowledge of classroom management principles and techniques" (p. 54). Teachers should have had a set of routines and strategies to establish classroom procedures, organize classroom activities, keep them on track, and respond to student misbehavior (König et al., 2011). Teachers also used their knowledge of instructional strategies to organize the

classroom environment and implement courses that promoted student learning. Successful teachers had a full range of strategies and practices to arrange lessons, made the classes run smoothly, and encouraged student participation in the class activities.

2.3.1.2. Content Knowledge

Teachers' content knowledge is about understanding that the teacher was imparting a specific body of knowledge that could help students understand important ideas in a subject and applied them in different contexts. To do this, in addition to facts, concepts and procedures, it is also important for them to know understand what the relationship between the ideas and their connection to other areas was. To help students understood important ideas in a subject and applied them in different contexts, Shulman (1986) suggested that "teachers must not only understand that something was the way it was, but they must also understand why it was that way" (p. 9). Therefore, the content knowledge of teachers focused on a strong understanding of the subject that they were going to teach in the school.

2.3.1.3. Pedagogical Content Knowledge

The concept of pedagogical content knowledge was developed by Schulman in the mid-1980s. In addition to subject knowledge and general teaching skills, he argued that it was necessary for teachers to have the capability to deliver topics in ways that learners could follow (Neumann et al., 2019). In these cases, teachers should be aware of how to make a subject easy

or challenging for students. This included knowing what students' biases were and what strategies were best to address misconceptions.

In recent reviews, it has been demonstrated strongly that pedagogical content knowledge was one of the most important elements in teaching (Coe et al., 2014). This empirical study showed that pedagogical content knowledge must be combined with how learners respond to the content. Furthermore, pedagogical content knowledge was not static in the sense that teachers need to investigate why the learner made certain errors in order to find out why they did so (Neumann et al., 2019).

Shulman (1987) emphasized that "pedagogical content knowledge was the knowledge that distinguishes teachers from content experts and was a special blend of content and pedagogy" (p. 8). This could include a broad understanding of how a field operates, as well as how to adapt it to the interests and capabilities of the learners within the field, and how to teach it in a classroom situation. Schulman said that "teacher competence lied in their ability to take the content knowledge he or she possessed and put it into a form that was effective in the classroom while adapting to changes in the students' capabilities and context" (1987, p. 15).

Shulman (1987) described the knowledge base that constitutes instructional content knowledge. This knowledge included propositional knowledge, case knowledge, and strategic knowledge. Propositional knowledge meant that knowledge was based on research ethics, norms, and teaching standards. This usually referred to the content of the curriculum. Case knowledge referred to knowledge about specific events, usually derived from practice. Teachers should

explain the principles and teach the teaching norms. The foundation of strategic knowledge was the capability to understand the principles, codes, and norms in terms of how to develop instructions that were of high quality in any given situations (Neumann et al., 2019). Briefly, teaching content knowledge encompassed four main points. The first was teachers' instructional orientation, which could be interpreted as teachers' understanding and beliefs about their subject and teaching methods. The second item was teaching knowledge, which could be interpreted as the timing and method of teaching. The third was the evaluation of knowledge: what should be taught, why it should be taught, and how it should be taught. The fourth referred to the understanding of the students' acceptance and the adjustments of teaching strategies.

2.3.2. Teachers' Knowledge Regarding SRL

As Karlen et al. (2020) suggested, there was not adequate research on the explicit distinction between teachers' knowledge in different areas, for example the content knowledge regarding SRL. The definition of teacher's content knowledge was the understanding of the subject matter that they taught as well as knowledge in the specific areas that were organized in a way that showed a deep understanding of that particular subject matter on a comprehensive level (Karlen et al., 2020). Teachers were responsible for knowing the content of the standards and it was critical to focus on how the process of SRL was understood within the context of SRL content knowledge (Dignath-van Ewijk & van der Werf, 2012). SRL content knowledge included an enhanced understanding of SRL theory and concepts, as well as knowledge and experience of the

teacher as a self-regulated learner. SRL was also a comprehensive concept that allows metacognitive knowledge about the kinds of strategies to use in a specific learning scenario, as well as their features and purposes, a higher comprehension of the concept of SRL, and a theoretical understanding of its implementation (Karlen et al., 2020).

Pedagogical content knowledge indicated the knowledge of teachers used to help students access specific content and represents knowledge about student concepts and teaching strategies in a particular domain. Pedagogical content knowledge was related to teachers' instructional practices and students' development and acquisition of knowledge in specific domains (Backfisch et al., 2020; Fauth et al., 2019; Förtsch et al., 2016). As part of pedagogical content knowledge in the context of SRL, it was required for teachers to become aware of the different ways to cultivate SRL in the classroom and encouraged students to acquire SRL based skills during their teaching. This included being able to contact different teaching practices that might have the potential to promote SRL directly (Paris & Paris, 2001) or directly by providing students with the potential and environment that made them more likely to participate in SRL (De Corte et al., 2004; Perry et al., 2008).

According to findings from intervention studies, teachers' competence in SRL could be cultivated and they could be helped to develop it (Kramarski & Kohen, 2017; Xu & Ko, 2019). However, studies of pre-service and in-service teachers at different levels of education showed that many teachers had a vague and unclear concept of SRL (Dignath-van Ewijk & van der Werf, 2012; Glogger-Frey et al., 2018). Although teachers, especially less experienced teachers, had

positive beliefs about cultivating SRL, they had a lack of knowledge regarding how to cultivate SRL and the different teaching practices that supported SRL in the classroom (Barr & Askell-Williams, 2019). Despite the fact that Peeters et al. (2014) stated that teachers generally believed that they were put in an important place in their students' self-regulation activities, most of them could not teach their students self-regulation principles or how to enhance the self-regulation skills of their students in the classroom. A lack of knowledge about learning, motivation, and development was due to teachers' education philosophies and the curricula they receive for their training (Barr & Askell-Williams, 2019), which focused more on content knowledge and the mastery of teaching methods than on learning, development, and motivation principles (Geduld, 2019).

Karlen et al. (2020) examined how important teachers' knowledge, beliefs, and learning motivation were in relation to SRL in the classroom. They collected data from 106 elementary and secondary teachers, and the authors explored the knowledge of teachers regarding SRL based on two aspects: content knowledge regarding SRL and pedagogical content knowledge regarding SRL. According to the results, there were very few pedagogical knowledge associated with SRL. However, their beliefs and motivation to implement SRL were higher. Spruce and Bol (2015) also demonstrated the same conclusion. The understanding of teachers regarding SRL was very limited, and there were even misconceptions regarding SRL. They reported that knowledge regarding SRL varies widely among teachers. Xu and Ko (2019) also conducted interviews with 11 teachers. The study participants were trained in SRL knowledge. Based on the

result, most of the interviewees acknowledged the changes of their understanding regarding SRL-based instruction in the training. Moreover, this evidence showed that teachers had a huge amount of potential to learn and got better at SRL.

2.3.2.1. Teaching Strategies of SRL

The main goal of direct teaching of SRL is to demonstrate and suggest that the purpose of applying a particular method was important, what skills were needed to implement the method, and when or in what circumstances it applied (Dignath-van Ewijk et al., 2013; Veenman, 2011). Intervention studies showed that targeted strategic training could effectively support strategies (Donker et al., 2014). As a result, students could receive direct strategy guidance in a variety of ways, such as by being encouraged to apply strategic behaviors, asking specific questions related to learning how to use SRL, or explaining which techniques to use and modeling them as they solve problems (Paris & Paris, 2001; Pressley & Harris, 2006). Educators found that having clear guidance on implementing SRL through informing students what they must follow, monitor, and regulate policy implementation to be very effective (Greene et al., 2019).

Taking the constructivist view into consideration, teachers might develop an effective environment for students to learn, by using indirect teaching methods (Dignath & Büttner, 2018). First, constructivist learning was situational learning that should took place in activities similar to real life because it challenged students with real and meaningful problem structures (Mayer & Wittrock, 1996). Teachers could provide students with complex, effective learning activities that

would reinforce subject-specific learning skills and consolidate their knowledge of the subject matter. Second, teachers could adopt the learning sharing method (Slavin, 1996). Since students communicated similarly, however, not exactly on the same level as their teacher, social interaction within the class facilitated the discussion of the topic, which usually led to a deeper understanding of the subject. Teachers could provide autonomy for students by opening them up to the content, methods, collaboration, and organization of their learning. In other words, let students chose what to do, when to do it, with whom, and for how long (Karlen et al., 2020). Third, teachers provided support and feedback in challenging situations based on students' individual needs and encouraged students to adjust their learning through self-monitoring and self-evaluating (Panadero et al., 2019).

2.3.3. Teachers' Knowledge in Physical Education

Elementary school PE teachers are responsible to help children develop coordination skills, learn the value of teamwork, love physical activity, and develop good hygiene habits while guiding their physical development and growth. Many of these coaches are also the teachers at the school's professional sport teams, instructing the students in technical sports like basketball and volleyball. PE teachers also usually taught health and nutrition classes. Therefore, general pedagogical knowledge, content knowledge, and pedagogical content knowledge are important for PE teachers.

Firstly, general pedagogical knowledge showed PE teachers' ability to lead teaching. They not only needed to provide healthy movement for students, but also needed to develop specific motor skills. Second, content knowledge in sports was usually defined as knowledge about sports (Arnold, 1979). Knowledge about sports could come from sports physiology, sports sociology, biomechanics, sports history, sports control, and sports pedagogy (Backman & Barker, 2020). Finally, contemporary understandings of content knowledge and pedagogical content knowledge in PE were primarily behavioral, focused on measuring and tested content knowledge and its implications for pedagogical content knowledge (Iserbyt et al., 2017; Ward & Ayvazo, 2016). Backman and Barker (2020) analyzed the impact of pedagogical content knowledge on PE teachers and summarized three views. First of all, PE teachers needed to be knowledgeable about how to conduct activities using correct techniques, know tactics, and know the rules and etiquette that were involved. Second, PE teachers needed to be able to recognize errors and create tasks according to them. Furthermore, PE teachers were also expected to understand how to choose proper tasks as well as how to provide feedback to students.

2.4. Relationship Between Teachers' Beliefs and Knowledge Regarding SRL

2.4.1. Relationship Between Teachers' Beliefs and Knowledge

Many researchers have acknowledged that "distinguishing knowledge from belief is a daunting undertaking" (Pajares, 1992, p. 309) and that it is often difficult to bypass conceptual

overlap between the two constructions (Vosniadou, 2019). However, some researchers felt that some definitions of beliefs and how they differ from knowledge were necessary to make it possible to study their impact on teacher decision-making and problem-solving (Dignath-van Ewijk & van der Werf, 2012; Lombaerts et al., 2009; Spruce & Bol, 2015).

As noted in the review above, teachers' attitudes to education referred to teacher beliefs of education, which form a sub-part of their overall beliefs (Pajares, 1992). Beliefs included attitudes and subjective norms. As a result, it was hard to distinguish between their personal preferences and their views about what education should be like. By objectively extracting and summarizing patterns in facts, knowledge was created. On the other hand, belief was emotional, so it involved some levels of subjective assessment (Dignath-van Ewijk & van der Werf, 2012). Based on the analysis, new knowledge could be acquired by teachers, but it was their beliefs that made a huge impact on their decision process and if new knowledge was accepted or not. Traditionally speaking, teacher knowledge was usually examined from the cognitive perspective, which was different from the two angles of investigating beliefs. Knowledge and beliefs were so intertwined that it was difficult to separate them completely in a simple assessment.

When teachers worked in classroom practice, their behavior was influenced by beliefs and knowledge. In a research done by Bray (2011), he explored the impact of the knowledge and beliefs of fourth-grade teachers on how they helped students correct their errors when teaching mathematics in class. Through case studies, the researcher discussed the relationship between teacher error handling practices and teachers' beliefs and knowledge. As demonstrated in the

study, the connection between the way teachers deal with student errors in classroom discussions of mathematics and their beliefs and knowledge was clear. Some teachers' responses were particularly more knowledge-related, while beliefs were shown to have more impact on the responses from the others. Therefore, distinguishing between beliefs and knowledge clearly was difficult.

Most researchers on the beliefs and knowledge of teachers concluded that the former was a better teacher behavior predictor compared to teacher knowledge (Askell-Williams et al., 2012). There were various explanations to support the point. One was that it was easier to learn knowledge than to apply knowledge to study and work. However, belief usually impacts teacher's daily life from time to time. A lot of research has empirically supported the correlation between beliefs and daily behavior (Staub & Stern, 2002).

Even though it is hard to separate teacher beliefs from knowledge, it is necessary to differentiate between the constructs of beliefs and knowledge clearly. While beliefs are generally considered to be more effective, knowledge is considered to have higher epistemic status due to its greater justifiability when compared with beliefs (Pajares, 1992). To investigate the effects of beliefs and knowledge on teacher decision-making and problem-solving, it was important to know the connection between the two.

Firstly, research has shown that teachers' beliefs and knowledge can impact their instructional practices in the classroom. For example, teachers who hold strong beliefs about the importance of student engagement and active learning may be more likely to use these strategies

in their teaching practices (Santos & Miguel, 2019). Similarly, teachers who have a strong understanding of subject matter and pedagogy may be more effective in conveying that knowledge to their students (Pajares, 1992).

Secondly, understanding the relationship between teachers' beliefs and knowledge can help to inform teacher preparation programs. By identifying the beliefs and knowledge that are most closely related to effective teaching practices, teacher preparation programs can better equip teachers with the skills and knowledge, they need to be successful in the classroom. By identifying areas where teachers may have gaps in their knowledge or where their beliefs may be in conflict with effective teaching practices, professional development programs can focus on addressing those areas and improving teacher effectiveness.

2.4.2. In the Context of SRL

Dignath-van Ewijk and van der Werf (2012) analyzed the role of teacher beliefs and knowledge in SRL. It involved many perspectives of teacher beliefs and became a complicated structure to define them in the context of SRL. First, this included teachers' overall view that learning could be understood as a procedure of transmitting and constructing knowledge. Second, the beliefs about cultivating SRL covered guiding and fostering the use of SRL strategies. Examples were like the beliefs about the number of strategies to guide at a time, and the instructions on combining particular SRL strategies and course contents. Noted that this was also true for teachers' knowledge. First, teachers should know the importance of providing

students with strategies before they learned and giving them autonomy. The second aspect was how much teachers possessed the content knowledge and pedagogical content knowledge of SRL. Askell-Williams et al. (2012) discussed teachers' knowledge of SRL in content knowledge and pedagogical content knowledge about cognitive and metacognitive learning strategies. Their result showed that novice teachers had lacked strong of knowledge regarding SRL teaching strategies.

Similarly, in classroom practice, teachers' beliefs, and knowledge regarding SRL were equally inseparable. Dignath (2016) pointed out that when teachers had more positive understanding regarding SRL activities in schools and deeper belief of SRL benefits to students, they would spend more time and energy and create a SRL friendly environment to facilitate the deployment of SRL strategy. However, in order to provide a better SRL learning strategies and learning environment for students, teachers needed to master relevant knowledge.

2.5. Sources of Teachers' Beliefs and Knowledge

Mandasari (2017) proposed that factors influencing teachers' beliefs in English listening teaching included: 1) challenge of teaching materials; 2) easy access to content; 3) availability of knowledge; 4) the students' interest; and 5) workshop or training and personal experience. The influencing factors of teacher knowledge might include 1) educational qualification; 2) basic knowledge; 3) learning and training experience; 4) skills, subject matter and 5)students' age (Zhao et al., 2019). Soliman and Alenazi (2017) indicated that gender, teaching subject, and

years of experience could generate a huge impact on various aspects of teachers' beliefs and knowledge. The subject in this study was a pre-service PE teacher, and the theoretical framework was based on the SRL model, without involving other factors mentioned above. Therefore, this section focused on reviewing the sources of teachers' beliefs and knowledge to see if they might be influenced by those sources.

2.5.1. Sources of Teachers' Beliefs

As Richardson (1996) described, teachers' beliefs came from three fundamental sources: personal experiences, personal experiences of education and teaching, and personal experiences of formal knowledge (including school subjects and pedagogical knowledge). The source of teachers' beliefs influenced whether beliefs change and develop (Levin, 2015). Accordingly, investigating how teachers' beliefs developed should follow understanding the sources of their beliefs. Using these sources of beliefs, Fives and Buehl (2009) proposed six different sources of teacher beliefs, which were: formal training, knowledge systems, learning by observing, cooperation, teaching experiences, and self-reflection. Levin and Ye (2008) made a discussion about where the teacher beliefs of normal collected students and in-service teachers came from in their report. First, they reported the sources of beliefs of 84 pre-service teachers: 1) Their experience, family background, and personal education as K-12 students account for 35%. 2) The knowledge they acquired in teacher education, reading, theories, and professors' opinions account for 31%. 3) Their classroom observation and practical experiences during teacher

education account for 35%. Second, they identified the sources of beliefs of 22 teachers who entered the teaching career. 1) The teaching training programs contributed 28%. 2) The values of their families and the experiences they had as K-12 students contributed 27%. 3) Their teaching experience contributed 24%. 4) Their recent professional development and reading books and learning videos, accounts for 12%. 5) Their observations of other teachers, accounts for 8%.

2.5.1.1. Pre-service Teachers' Beliefs

Teachers are students before they become teachers. When they are students and are taught by other teachers, they naturally obtain some understanding about how teaching should be conducted effectively and efficiently based on their own experiences and feelings. These understandings ultimately affect their beliefs about teaching. So, compared to the novices in other industries, the novice teachers naturally have already brought beliefs of certain levels, even if they were new in the teaching careers. Lortie (2020) described this phenomenon as "experience-based teaching". After serving for years, the beliefs about teaching might change and evolve, due to more practical teaching experience. According to research (Clandinin & Connelly, 1987; Kagan, 1992; Richardson, 1996), the most important source of teaching and learning beliefs for novice teachers might be their schooling and teaching experience right after they started the service.

Mattheoudakis (2007) conducted a follow-up study in which he interviewed 66 pre-service English teachers in Greece to explore the development of their learning and teaching beliefs in a

teaching training program of three years. It has been found that when novice teachers teach in real classrooms, they could test what they learn about teaching in school and gain new ideas about how they could teach better. As a result, the actual classroom environment would be more challenging for teachers, putting higher demand on their specialties not only concerning their training and experience but also their knowledge of both pedagogical content and classroom management capabilities. Therefore, Levin et al. (2013) proposed that teachers, particularly new in-service teachers, need to spend more time reflecting on their teaching practices than they currently do. Also, Debreli (2012) focused on pre-service teachers' beliefs, and three English teachers who entered a nine-month teacher training program. After assessing their beliefs, the researchers found that the participants' beliefs changed with their personal teaching experiences in the program. Several papers demonstrated that teachers' beliefs could be impacted and changed by their classroom environment, individual experiences, and self-image changes in their teaching implementation (Seymen, 2012; Yuan & Lee, 2014).

2.5.1.2. Experienced Teachers' Beliefs

Experienced teachers' beliefs change as the instructional environment, teacher group, and content knowledge change (Levin et al., 2013). Ertmer et al. (2012) indicated that the teaching beliefs expressed by experienced teachers include classroom management, determining teaching strategies, and beliefs about student expectations and career planning. Their beliefs shifted from focusing on themselves to focusing more on students (Levin et al., 2013). Stergiopoulou (2012)

examined the beliefs of pre-service and experienced teachers about training and coaching foreign languages. The results showed that teachers with experience paid more attention to learners' interest and attitude rather than just textbook knowledge that should be mastered in foreign language learning. Levin et al. (2013) came to the same conclusion. Among teachers, there was a shift from a content-centered attitude among beginners to a learner-centered attitude among experienced teachers. Thus, experienced teachers have been found to pay more attention to students' particular expectations and beliefs. There was also research on teachers' beliefs, particularly in mathematics and science classrooms. It suggested that after teachers grew with more teaching experience, their beliefs focused more on students (Luft & Roehrig, 2007).

2.5.2. Source of Teachers' Knowledge

It is of great significance to study the sources of teacher knowledge and the importance of different sources to promote the development of teacher knowledge (Zhao & Fan, 2022). Teachers' background, knowledge, experience, and belief will all have an impact on the content and teaching methods they teach. Calderhead (1996) stated that teachers' knowledge could come from a variety of sources, including practical experience, daily practice, initial teacher education or professional development, and previous formal education. Savvidou and Economidou-Kogetsidis (2019) emphasized that teachers might obtain their knowledge from teacher education, classroom practice, and experience inside and outside the classroom. Knowledge was

not a stable entity, but something that was shaped, modified, modified, transformed, or strengthened.

Zhao and Fan (2022) analyzed the methods and results of 27 empirical studies on teacher knowledge sources. The results showed that the sources of teachers' knowledge were mainly affected by four aspects. First, the source of teachers' in-service experience was given more affect than they studied in a teaching education program and primary and secondary schools' learning. Second, teachers' experience and self-reflection, as well as communication with colleagues, were the most important sources of teachers' knowledge development. Third, educational training and internship experiences were the most important sources of knowledge in pre-service education. Fourthly, the usefulness of teachers' knowledge sources was influenced by knowledge categories, disciplines, education stages, and other variables, and shows certain individual differences. Therefore, the above results confirmed the importance of teacher training, self-reflection, collaboration, and communication, and indicated the necessity of improving pre-service education.

2.6. Research Questions

This chapter provided an overview of definitions and models of SRL, as well as a summary of the historical research on teacher beliefs and knowledge in the literature. The importance of SRL strategies in sports was also discussed. Previous studies have explored various aspects of SRL, such as teachers' beliefs and instructional strategies to incorporate SRL into teaching

practice. Some studies have also investigated the role of SRL in learning sports skills and have guided students to improve their expertise in metacognition and SRL through professional training. However, the use of instructional strategies depends on teachers' beliefs and knowledge. The teacher education program is a crucial medium for training normal PE college students. There needs to be more research on SRL in personal development-focused subjects like PE. Therefore, a literature review was conducted to identify the need for further research and propose the research questions.

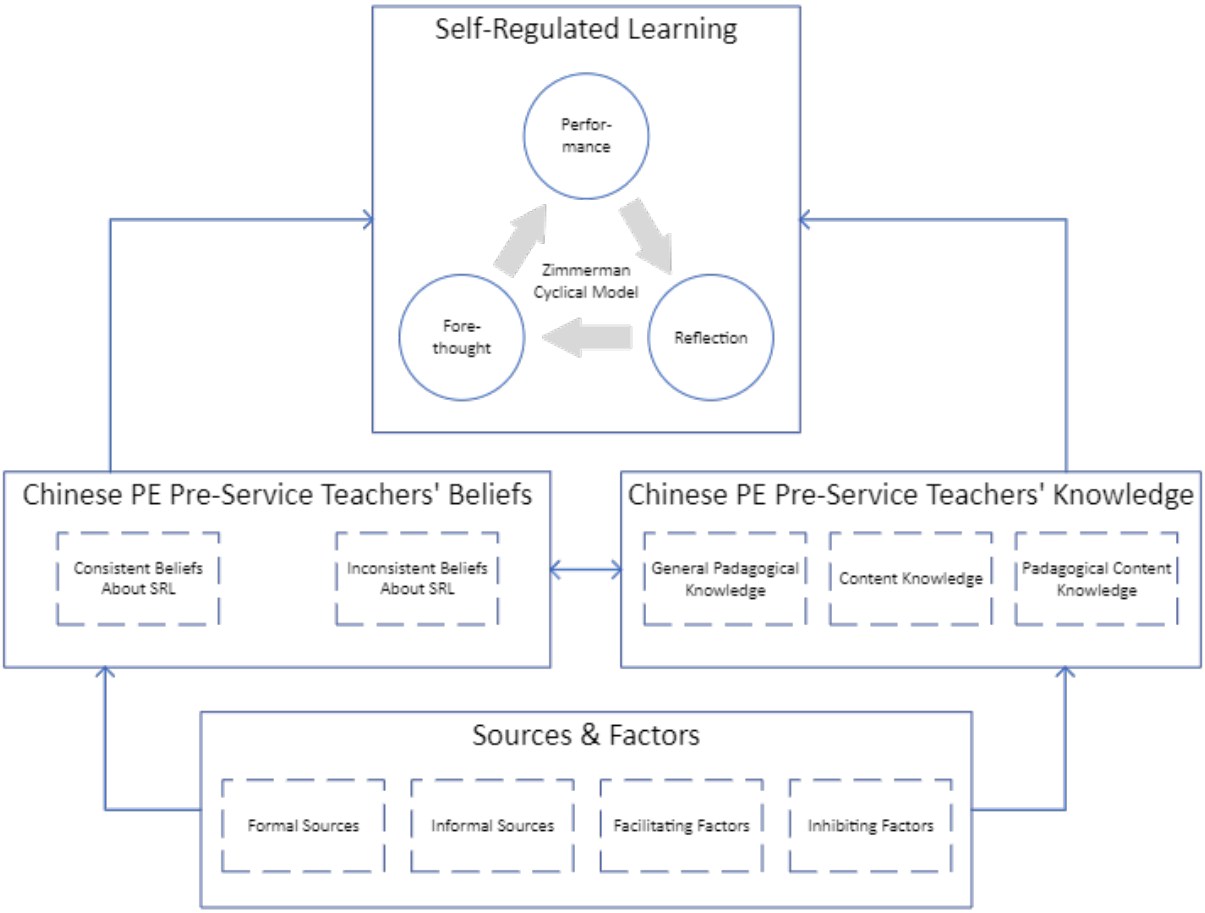
1. What are the beliefs and knowledge of Chinese PE pre-service teachers regarding SRL?
    a. What are the beliefs of Chinese PE pre-service teachers regarding SRL?
    b. What is the knowledge of Chinese PE pre-service teachers regarding SRL?
    c. How do the beliefs of Chinese PE pre-service teachers regarding SRL relate to their knowledge of SRL?
2. How are Chinese PE pre-service teachers' beliefs and knowledge shaped?

2.7. Conceptual Framework

The conceptual framework in Figure 4 focused on the SRL Zimmerman model and aimed to investigate Chinese PE pre-service teachers' beliefs and knowledge regarding SRL. The framework also sought to explore how their beliefs and knowledge were shaped, including formal and informal sources of knowledge, facilitating and inhibiting factors, by using arrows to

connect the box called "Sources & Factors" to the boxes called "Chinese PE Pre-Service Teachers' Beliefs" and "Knowledge". Additionally, this framework explored the relationship between beliefs and knowledge and whether they were linked to the SRL strategies. This model could be used as a guide for examining PE pre-service teachers' beliefs and knowledge regarding SRL, as well as the research on the application of SRL strategies in teaching and learning.

Figure 4 *Conceptual Framework*



Chapter 3. Methodology

Chapter 3 presented the methods and techniques applied in this research, which cover the research design, sampling, tools, procedures, and data analysis. The study examined the beliefs and knowledge of PE pre-service teachers with regard to SRL and explored the relationship between beliefs and knowledge as well as of underlying reasons behind them.

3.1. Design of Research Methods

To address the questions to be studied in the research, a mixed-methods design was employed. Creswell et al. (2003), the paper introduced six most used ways of designing. Three ways were concurrent, and the others were sequential. One of them applied mixed methods and follows a sequential style with the focus on explanation, i.e., the mixed-methods sequential explanatory design. The design has two sequential phases. The first phase collects quantitative data, and the second one gathers qualitative data. Then the data were explored for the research questions (Creswell et al., 2003). More specifically, the sequential explanatory design was employed because it used the qualitative results could be very helpful for better understanding the results obtained from the quantitative data (Ivankova et al., 2006). The first quantitative phase was the foundation of the second qualitative one, and the two were closely connected (Ivankova et al., 2006). The reason behind the approach was that the quantitative data and the statistical modelling of it confirm the intuitive understanding of the research questions by

assessing the statistical significance of the hypotheses derived from the research questions. Based on the statistical results, the qualitative data, and the analysis of it give in-depth interpretation by exploring from the angle of participants (Creswell et al., 2003).

3.1.1. Phase 1: Understanding Teachers' Beliefs

Research Question 1(a) was answered directly after estimating the quantitative statistics of teachers' beliefs in Section 3.2. *Beliefs About Learning and Teaching 3(BALT3)* (Darmawan et al., 2020) was feasible for the research and applied in the quantitative phase. The scale of Darmawan et al. (2020) was to test pre-service teachers' beliefs in SRL and assess for any inconsistencies with the theory. This scale has 58 items to distinguish between teachers' consistent and inconsistent beliefs and answer research questions 1(a). The first phase identified PE pre-service teachers' beliefs and divided them into three groups, which include high-consistent, middle-consistent, and low consistent beliefs with SRL.

3.1.2. Phase 2: Understanding Teachers' Knowledge and Contributing Factors

Research Question 1(b) was then addressed through interviews with pre-service teachers to assess their knowledge in Section 3.3, with interviewees selected based on their survey scores. Interviews were analyzed by the qualitative method to assess PE pre-service teachers' knowledge. The interview question was designed based on Spruce and Bol's instrument and phases in the Zimmerman model and revised to focus on SRL in PE.

Research Question 2 was addressed in Section 3.3. For those interviewees who provided differing quantitative answers to Research Question 1(a), the qualitative data were analyzed to investigate their knowledge sources and application attitude regarding SRL and to explore the factors and sources that contributed to different beliefs and knowledge levels as described.

3.1.3. Phase 1 + Phase 2: Understanding Relationship between Beliefs and Knowledge

Research question 1 (c) aimed to analyze the relationship between teachers' beliefs and knowledge by sorting out the results of the first and second phases. In the first phase, teacher beliefs were identified and divided into three groups (high, middle, and low consistent beliefs with SRL) through quantitative analysis of survey data. In the second phase, teacher knowledge was analyzed through interview data. To explore the relationship between belief and knowledge more clearly, the study conducted word frequency analysis of interview data using Nvivo to examine participants' preferences for different styles of knowledge. As a result, teacher knowledge was also divided into three groups: SRL, co-regulated learning, and externally regulated learning. By combining quantitative and qualitative data, the study aims to identify patterns between belief and knowledge, exploring how teachers at different levels of belief perceive their knowledge.

Figure 5 *Sequential Explanatory Research Design*

3.2. Phase 1 Quantitative Study

3.2.1. Participants Recruitment

A total of 406 original questionnaires were recovered, and 385 were left after reviewing. Ethics permissions were granted by EduHK human research ethics committee prior to any data collection.

3.2.1.1. Criteria for Participant Setting

Pre-service PE teachers at six universities were targeted for inclusion in the questionnaire sample. There were two critical for choosing six universities as research targets in this study. First, the six universities all offer PE programs and include compulsory PE courses, such as

Pedagogy, Sports Science, Sports Psychology, etc. Also, they set a practicum before students' graduation.

Second, the criteria for selecting participants were all PE students from national sports major universities or Project 211 normal universities. Six universities are best in sports, best in PE, and good in education in Mainland China, and they are representative and important among colleges and universities in Mainland China, also they may have a high motivation to implement the curriculum policies formulated by the state.

According to the Catalogue of Undergraduate Majors (the 2020 edition) released in 2020, PE is one of the education majors, and the graduates of PE were awarded a bachelor's degree in education. These major train students to master the basic theories, systematic knowledge, and skills in the field of PE, to understand the laws of PE, to have strong practical capability and to have comprehensive development of professional knowledge. After graduation, students may be engaged in sports teachers, extracurricular sports activities, extracurricular sports training, competition, and other jobs in middle schools. At the same time, the major strives to cultivate professionals with rich experience in school sports research, school sports management and social sports consulting. Key areas include education and PE, such as Pedagogy, Sports Science, Sports Psychology. Therefore, since students enrolled in PE programs are likely to become future PE teachers, it is more worthwhile to investigate their beliefs and knowledge in this domain. The general office of the Ministry of Education published a notice titled "Outline of Teaching Guidance for Various Major Courses of Regular Physical Education Specialty in

Common Institution of Higher Learning" (*Ministry of China of The People' s Republic of China*, 2004). Cultivating students' habits of inquiry-based learning and promoting the self-learning capability and practical skills of students in the continuous improvement of teaching methods are mentioned in curriculum objectives, basic teaching requirements and learning evaluation. The policy shows the significance of exploring the beliefs and knowledge of PE teachers regarding SRL and the relationship between the two, before they enter their service in schools.

3.2.1.2. Criteria for Selecting Questionnaire

There were three criteria for selecting a questionnaire. First, by reviewing the original questionnaire, it was found that there were three blank questionnaires in total, so they were removed. Second, the questionnaire with a single option was considered to be of no reference value, so a total of 6 questionnaires were removed. Third, the questionnaires with a duration less than 60 seconds were not considered to be referable, so a total of 9 questionnaires were removed.

Therefore, the participants in the quantitative part total have 385 normal college students. Of those, 61% males (n=237) completed the questionnaire, and 38% were females (n=148). Participants came from year1 to Year 4, however, junior students more than seniors. There were 143 students from year 1, 146 students from year 2, 54 students from year 3, and 42 from year 4. More than half, 79% of students showed they have received pedagogical training before in school. Also, the 175 students had teaching experience in primary/secondary/high school. 47.8% of students were willing to take follow up interviews.

Please see Table 1 for a detailed break-down of gender, grade, learning experience, teaching experience, and whether willing attend interview for the questionnaire sample.

Table 1 *Demographic Information Questionnaire Sample*

	Entire Sample Number	Entire Sample %
Gender		
Male	237	61.6
Female	148	38.4
Grade		
Year 1	143	37.1
Year 2	146	38
Year 3	54	14
Year 4	42	10.9
Learned Pedagogical Course		
Yes	304	79
No	81	21
Teaching Experience		
Yes	175	45.5
No	210	54.5
Willing to Take Follow up Interview		
Yes	184	47.8
No	201	52.2

3.2.1.3. Sample Size Considerations

385 pre-service PE teachers were recruited through literature review and interpretation of the BALT3 scale. There were three reasons that 385 participants were trustful sample size. First, the Rasch analysis was used in this study. According to the sample size analysis in Rasch. Org (*Sample Size and Item Calibration [or Person Measure] Stability*, 2022), a sample size between 250 to 500 was good enough to estimate Rash model with acceptable. The lower size limit was approved for reliable personnel and project estimates and for reliable statistical interpretation of the fitting statistics (Chen et al., 2013; Hagell & Westergren, 2016). For the sample size of 385, it gave us the 99% confidence for the estimated coefficients to fall within the interval of 0.34 logits centered at the true values. Second, 385 participants were close to previous study. BAIL1 and BALT2 was administered to 430 pre-service teachers and 366 pre-service teachers. Third, considering the participants came from the first to fourth years of the undergraduate PE program, both genders and six universities. In each gender, each grade, and each university, it was operationality efficient and well representative to have at least 8 students. So, the target number of participants was 384. Finally, 406 were recovered, and 385 questionnaires were used, it was very closed for target number size. Therefore, 385 was a trustful sample size.

3.2.2. Procedure

After potential candidates were identified, survey participants were recruited through social media, posters, and referrals from friends. Between July 2022 and August 2022, PE students from six universities were invited.

The researcher gave an online questionnaire to participants. Then, participants were completed the questionnaire online on a voluntary basis and within roughly 10-15 minutes. Questionnaire was collected in mainland China, and this study selected a platform more convenient for Chinese students to use. WJX.CN was an online platform for questionaries, exams and balloting in mainland China (问卷星, 2021).This platform integrated various features for users, including questionnaire designing, data collecting and customized reporting. In addition, survey results could be even automatically descriptively analyzed for drawing quick and initial conclusions. Therefore, WJX.CN was a very suitable platform for this study.

In the beginning of the demographic questionnaire, participants were asked to leave their contact information for them to be enrolled in a lucky draw to appreciate their time and effort and to motivate them to answer the items in the questionnaire carefully. The researcher was randomly select 50 lucky participants to award RMB ¥50 supermarket gift cards.

Answers to all questionnaires were kept confidential. After the participants completed the questionnaires, the researchers were collected all the questionnaires and store them securely in a

password-protected folder. During the collection and analysis of the research, only the students and faculty involved in the research had access to the original documents.

3.2.3. Measures

3.2.3.1. Demographic Survey

The demographic survey was employed to label the samples and estimate how much the surveyed subjects represent the universe of PE pre-service teachers in colleges. The demographic survey collected participants' gender, grade, amount of training and teaching experience etc. This information helped the researchers to answer the third research question, by combining the participants' background past and data from the BALT3 survey and interview to analyze the potential reasons that why they have different level of beliefs and knowledge regarding SRL.

Additionally, the demographic survey started by asking the participants to leave their contact information for them to be enrolled in a lucky draw to appreciate their time and effort. In the last item in the demographic survey, subjects were also asked about their willingness to participate in a following interview. The complete demographic survey could be found in Appendix A.

3.2.3.2. Beliefs About Learning and Teaching 3 Scale Survey

Beliefs About Learning and Teaching (BALT) was a scale testing pre-service teachers about their beliefs in SRL (Darmawan et al., 2020). In other words, the target of the scale was to assess if the beliefs system of a teacher contains any inconsistency with the SRL theory. BALT3 was

the latest version of BALT after being enhanced by Darmawan et al. and includes 58 items. In addition to the 28 items for testing the beliefs inconsistency with SRL, it also had 30 consistent items. In total, Darmawan and his colleagues (Darmawan et al., 2020) concluded seven factors that might influence teachers' consistent or inconsistent beliefs of SRL, i.e., Nature of Constructive Learning (ConL), Quick and Natural Learning (NatL), Constructive Teaching (ConT), Transmissive Teaching (TranT), SRL Achieve (SRLAc), SRL Negative (SRLNeg), Locus of Learning Control (LoLC).

BALT3 was constructed based on BALT1 and BALT2. To be more accurate, there were 50 items in BALT3 from BALT 1 and 53 items from BALT2 initially, so BALT3 was created with 78 items. To remove the ineffective items, an item selection standard based on the factor loadings was applied. Finally, BALT3 ended up with 58 items. In terms of the samples collected for the studies of BALT3, it fully leveraged the existing results and requires no additional survey. In the research of BALT1, 430 teachers who had not entered service participated in the survey. For BALT2, it had 366 participants. As a result, the search based on BALT3 had 796 samples in total.

The item selection process worked as described in the following. Cronbach's alpha of BALT3 was analyzed to measure how BALT3 was internally reliable. The analysis approved BALT3 was internally reliable because Cronbach's alpha of most of the question sections in BALT3 is larger than 0.7. In addition, discrimination indices, which indicate the degree to which a program discriminates between different levels of respondents' measured characteristics, were

explored by Conquest IRT. Theoretically, discrimination index values could range from -1.0 to 1.0. If discrimination indices were negative, the associated items were removed. On the contrary, acceptable discrimination indices were above 0.2. Such items were kept in the questionnaire (Boopathiraj & Chellamani, 2013). Therefore, the above assessment led to the current items in BALT3 of 58 items. Participants of it were supposed to rate their answers in a Likert style by five levels. The lowest level was numbered by 0, representing "strongly disagree". Other levels were consecutive numbers up to 4, which indicates "strongly agree". The complete BALT3 scale questionnaire could be found in Appendix B.

3.2.3.3. Translation of BALT3 in Chinese

The original language of BALT3 was English, while the research object of this study was college students in Mainland China, so there was need a translating from the original scale to Chinese. This process was tough and intensive in terms of time and efforts. After being translated, the original material and the target material must be the equivalent (Beaton et al., 2000; Cha et al., 2007; Sperber, 2004). The forward-backward translation method was used in this research because this method ensures the equivalence required by any cross-cultural and cross-ethnic translation(Cha et al., 2007; Sperber, 2004). Three bilinguals were involved in the translation, one translator translates the scale from English to Chinese and another translator did the backward translation. The backward translated scale was evaluated by the third translator against the original scale. Both should be equivalent semantically, idiolectally and conceptually.

Though difficult, the method was worth and efforts because it provides the required equivalence (Weeks et al., 2007).

Cha et al. (2007) suggested that translators should not translated word for word but should adopted conventional translation methods to translate the meaning of the original scale and to make the translation equivalent to the original one. In the process of translation, in order to maximize the equivalence between the source text and the target text, the following points were considered in translation. First, the equivalence of words and phrases in meaning should be achieved, which was called the semantic equivalence. The translation used short and easy-to-understand phrases with simple key words. Second, translator should be used equivalent expressions in translation, which was called the idiom equivalence. The idioms and colloquial expressions in the target language and the source language should be conveyed the same information. Last but not least, the conceptual equivalence was also important to ensure that the same meanings were conveyed when describing concepts.

3.2.4 Data Analysis

3.2.4.1 Rasch Modelling

Georg Rasch initially developed the classic Rasch model in 1980 (Rasch, 1993). The model was designed for modelling and analyzing dichotomous data such as right/wrong answers in surveys (Von Davier & Molenaar, 2003). The polytomous Rasch model was an enhancement of

the dichotomous Rasch model. It was a statistical model of measurements, and it had potential applications to any data collected in processes of measuring willingness and/or capability (Andrich, 1978). Usually, the data to be modelled were responses to items that had successively increased integer scores. For instance, the model could be deployed to analyze items for assessing educational items that use Likert scales. In this case, higher integer scores represent higher degrees of agreement, competence, understanding, and attainment.

Rasch modelling is suitable for analyzing the data collected in the survey of this study. First, the survey adopted the five-point Likert scale, which is a kind of measures that can be modelled by the Rasch model. Second, the original paper of BALT3 adopted the Rasch model to analyze the responses to BALT3 and discussed and confirmed about the validity of doing so (Darmawan et al., 2020). Third, the Rasch model has been used and developed for tens of years, since its invention. Many academic papers in the field of education adopted the Rasch model to analyze questionnaires based on Likert scales, which demonstrated the validity of the Rash model (Darmawan et al., 2020; Lombaerts et al., 2009; Vosniadou et al., 2020).

3.2.4.2. Partial Credit Model

There were many variants of polytomous Rasch models in the literature (Matthias von, 2016). The major differences lied in the handling of person locations, item difficulties, and score thresholds. Person locations referred to the personal effects on the responses to items on average. Each person had his/her own location, which could be potentially different from other persons.

Item difficulties were used to denote the average person abilities required for items to obtain average item points. An item could potentially be scored higher than other items, which was captured by this effect (Alagumalai et al., 2005). Lastly, thresholds represented the effect difference between scores of each item. If a threshold between two scores in an item had statistical significance, choosing the two scores in this item among subjects was significantly different.

The partial credit model considered personal locations, item difficulties and thresholds between scores. It was different from other models mainly in that it estimates the thresholds between every pair of successive scores in each item (Rasch, 1993). Therefore, the model had a higher degree of freedom and a potentially higher fitting accuracy in comparison with other models, for example, the rating scale model. Noted that the rating scale model assigned the same thresholds to all items.

This research focused on the partial credit model and the rating scale model to do the Rasch modelling and analysis. First, both models were applied to the collected responses to the survey. Second, multiple fitting performance metrics were estimated to measure how close both models can be to the responses, at the price of degrees of freedom. In other words, the metrics are all estimators of prediction errors of the two models, with the trade-off between goodness of fitting and model complexity being considered. Thirdly, a model was chosen by comparing the fitting performance metrics, and its estimates were used for analyzing the survey results.

The rating scale model was formulated in the first place. Denote the person locations by β_n, $n = 1, 2, \dots, N$, the item difficulties by δ_i, $i = 1, 2, \dots, Q$, and the thresholds by τ_k for $k = 1, 2, \dots, M$. The rating scale model could be formulated as

$$P[X_{ni} = x] = \frac{exp\,(\sum_{k=1}^{x}(\beta_n - \delta_i - \tau_k))}{1 + \sum_{j=1}^{M} exp\,(\sum_{k=1}^{j}(\beta_n - \delta_i - \tau_k))}$$

for $x > 0$ and

$$P[X_{ni} = 0] = \frac{1}{1 + \sum_{j=1}^{M} exp\,(\sum_{k=1}^{j}(\beta_n - \delta_i - \tau_k))},$$

where X_{ni} represented the n'th subject's answer to the i'th item and x denotes the answer scores of $0, 1, 2, \dots, M$. Here, it was assumed that there were M item points in Q items and N subjects were tested in the survey.

On the other hand, the partial credit model followed

$$P[X_{ni} = x] = \frac{exp\,(\sum_{k=1}^{x}(\beta_n - \delta_i - \tau_{ki}))}{1 + \sum_{j=1}^{M} exp\,(\sum_{k=1}^{j}(\beta_n - \delta_i - \tau_{ki}))} \quad (1)$$

for $x > 0$ and

$$P[X_{ni} = 0] = \frac{1}{1 + \sum_{j=1}^{M} exp\,(\sum_{k=1}^{j}(\beta_n - \delta_i - \tau_{ki}))}, \quad (2)$$

where each item had its own thresholds τ_{ki}. Noted that there was difference between τ_k in the rating scale model and τ_{ki} in the partial credit model. By estimating item thresholds for each item, the degree of freedom of the partial credit model significantly increased. Once the

parameters were estimated by the conditional maximum likelihood method, different effects could be analyzed and tested for statistical significance. An R package called "TAM" to estimate the model were applied. The formulation used in TAM was different from ours (Adams et al., 1997). For most of the parameters and their standard errors estimated by Tam, they could be converted to the parameters used in our formulation.

When comparing person ability by gender, the null hypothesis used by the three tests were the same and was given by

$$H0: F(x) = G(x)$$

for all $x \in R$, and the alternative hypothesis follows

$$H1: F(x) \neq G(x)$$

for at least one $x \in R$, where F and G were two cumulative distributions functions to compare. Intuitively speaking, the null hypothesis means the person ability of different gender was from the same distribution. When comparing person ability based on other conditions, the null hypothesis of Kolmogorov-Smirnov Test was given by

$$H0: F(x) \geq G(x)$$

for all $x \in R$, and the corresponding alternative hypothesis follows

$$H1: F(x) < G(x)$$

for at least one $x \in R$. Intuitively speaking, the null hypothesis means the person ability of the participants from F was stochastically smaller than the person ability of the participants from G, indicating a high probability of seeing lower person ability from F than G. For Wilcoxon–

Mann–Whitney Test and Brunner-Munzel Test, the null hypothesis was different and was given by

$$H0: F(x) \geq G(x)$$

for at least one $x \in R$, and the corresponding alternative hypothesis follows

$$H1: F(x) < G(x)$$

for all $x \in R$. Note that the alternative hypothesis was the same as Kolmogorov-Smirnov Test's null hypothesis. If the null hypotheses were rejected by the three tests, all tests give the same conclusion that the person ability from F was larger than the person ability from G in some degree.

3.2.4.3. Model Implication for Measuring SRL Beliefs

After the partial credit model was estimated, the statistical significance of the parameters could be assessed, which showed whether an effect was strong enough to contribute to the different answers made by subjects to items. For instance, if the person location β_n of the n'th subject was significantly negative, it was statistical evidence that the subject was more likely to rate Strongly Disagree and/or Disagree to items in the questionnaire. As a result, the subject possessed relatively low beliefs regarding SRL. But an important underlying assumption of this implication was that an answer of an item was given a higher answer score if the answer was more aligned with strong beliefs regarding SRL.

For another more concrete example, Item #38 was "When students could learn to self-regulate their learning, their achievement improves". If the item difficulty δ_i of the i'th item of five answers was significantly positive, it shows there was a clear trend to choose Strongly Disagree and Disagree by subjects in the Likert scale used by the research in this proposal, where disagree answers (a.k.a. Strongly Disagree and Disagree) were assigned small scores and agree answers (a.k.a. Agree and Strongly Agree) were assigned large scores. In other words, this item required high person abilities to answer item points of Agree or Strongly Agree. If the item difficulty was not significantly different from zero, the answers from subjects were centered at the middle answer (a.k.a. Neutral in the above example). A widely used type of plots called Wright maps (*IRT item-person maps with ConQuest integration*, 2020) that gave a better illustration of this pattern could show the Thurstone thresholds of all items and the histogram of all person abilities.

This research conducted the following analysis by the partial credit model with the aid of the R package "TAM". First, the descriptive statistical analysis was used for summarizing the intuitive features of the responses to the items from the subjects. By showing basic statistics, researcher could summarize the characteristics of the central tendency, dispersion, and shape of the empirical distribution of each item's all responses and each subject's all responses. Secondly, after estimating the partial credit model, the statistical significance of the parameters could be examined, and insignificant estimates could be investigated. Potential reasons behind insignificant estimates could be discussed to better understand the data ineffectiveness. The

goodness of fitting was also important to see if the model could fit the data, which could be assessed by various indices, i.e., chi-squared, normed chi-squared, AIC, BIC, etc. Finally, various plots could be shown to illustrate the difference between items and persons.

3.3. Qualitative Study

3.3.1. Participants Recruitment

After collecting the questionnaires, 20 volunteers were selected for follow-up interviews lasting between 30 to 40 minutes. The researcher used a purposeful sampling procedure to select interviewees that were representative of the interview participant pool.

3.3.1.1. Criteria for Participant Setting

There were three factors to consider when choosing interviewees. First, after doing data analysis of the BALT3 questionnaire, teachers' beliefs of SRL were distinguished into three levels, i.e., high, middle, and low consistent beliefs with SRL. This was based on the participants' abilities, which were obtained from the survey. The results showed that some students had significantly positive abilities, insignificant abilities, and significantly negative abilities. Interviewees were selected from participants with high, neutral, and low levels of beliefs based on their survey scores. Ideally, all students would be ranked in order of their ability and the top eight, middle eight, and last eight would be chosen. However, it was difficult to confirm the willingness of every participant to join the interviews. So, when the participants

were contacted, the choices of the participants were sequentially narrowed down from a pool. Second, it was important to separate junior and senior students because they might have different amounts of training and teaching experience. So, in terms of students' grades, they were split into two groups, i.e., the junior group (Year-1 and Year-2) and the senior group (Year-3 and Year-4). Third, gender was also an important factor.

Therefore, the original plan was to recruit 24 participants for interviews, but only 20 were finally interviewed because, even with the incentive mechanism, it was still difficult to recruit the planed number of participants in limited time. Based on the results shown in Section 4.2 the 20 interviewees possessed totally different consistency levels of beliefs with SRL and presented significantly different levels of knowledge on SRL, which gave the researcher enough information to achieve meaningful conclusions in the qualitative analysis.

Table 2 *The Interview Participants' Ratios Have Been Completed/Planned*

Grade	Gender	High	Middle	Low
Year 1&2	Male	2/2	2/2	2/2
	Female	1/2	1/2	1/2
Year 3&4	Male	2/2	2/2	2/2
	Female	2/2	2/2	1/2
Note: Ratios are completed/planned				

3.3.1.2. Sample Size Considerations

The qualitative study had a total of 20 normal college student participants, with 12 males (60%) and 8 females (40%) completing the interviews. Participants were from Year 1 to Year 4, but there were more junior students (n=11) than senior students (n=9). Among the interviewees, 90% indicated that they had previously received about pedagogical training in school, and over half of the 14 interviewees had prior teaching experience. Additionally, based on the survey scores, PE pre-service teachers' beliefs about self-regulated learning (SRL) were categorized into three levels: high, middle, and low consistent beliefs with SRL. Seven interviewees had high-SRL-consistent beliefs, 7 had middle -SRL-consistent beliefs, and 6 had low-SRL-consistent beliefs.

Please see Table 3 for a detailed break-down of gender, grade, learning experience, teaching experience, and consistency beliefs with SRL that they showed in surveys.

Table 3 *Interview Information Sample*

	Entire Sample Number	**Entire Sample %**
Gender		
Male	12	60
Female	8	40
Grade		
Junior Grade (Year 1 and Year2)	11	55
Senior Grade (Year3 and Year4)	9	45

Learned Pedagogical Course		
Yes	18	90
No	2	10
Teaching Experience		
Yes	14	70
No	6	30
Consistency of Beliefs with SRL		
High	7	35
Middle	7	35
Low	6	30

3.3.2. Procedure

After the quantitative results were collected and analyzed, interview participants were recruited through telephone or email invitation. The questionnaire included an item asking participants if they were willing to be interviewed. Therefore, the invited participants indicated their willingness to participate in the interview prior. Among these volunteers, the researcher was select 20 pre-service teachers as standard samples of high, neutral, and low beliefs in SRL. The interview was supposed to last about 40 minutes and was carried out on ZOOM or VooV Meeting. Interviews with 20 PE pre-service teachers were completed between August 2022 and December 2022.

For encouraging questionnaire subjects to actively participate in the second-stage interview, the researcher indicated the incentive measures eventually in the questionnaire. The 20 selected interviewees received supermarket gift cards of ¥100 and still keep the chance to win the lucky draw in the questionnaire. In other words, they had the potential of getting two awards. In addition, researchers could provide relevant e-books to participants who were interested in SRL and could discuss their questions.

In addition, prior to the interview, 20 respondents received an explanation of the measures to protect their personal information, and then they signed a written statement letter to acknowledge that they understood the aforementioned measures. Interviews were classified. Any records and materials generated in the interviews were be kept in a filing locker. Furthermore, subjects were be assigned a pseudonym of their own choice to appear instead of their name in notes, articles, or subsequent official letters.

3.3.3. Measures

3.3.3.1. Interview Protocol

In the interview section, there have three targets.

1. Assess how much SRL knowledge interviewees have and how they learn/obtain.
2. Address how is Chinese pre-service PE teachers' beliefs regarding SRL relate to their knowledge.

3. Explain how PE pre-service teachers' beliefs and knowledge are shaped.

This study designed 23 questions about pre-service PE teachers' knowledge.

First, before the interviewer gave the leading questions, interviewees could explain their own thinking of SRL. Then, some following questions created to be consistent SRL in sports and based on the impression on SRL, importance of SRL, difficulties faced by SRL. For example, a sequential question to know interviewees' learning experiences and learning difficulties faced by SRL, "Do you have an experience in which you learnt something all by yourself and achieved good results? Did you guide and direct yourself or under the supervision of someone else? Did you try to evaluate your learning performance all by yourself? What do you feel about this experience?". In addition, there were some questions to explore interviewees impression on SRL specially in PE, "How would you describe the features of a PE classroom that foster the form of self-regulated learning? Which one of them is the most important? Which one of them is the most difficult to implement?".

Furthermore, some specific knowledge interview questions developed based on Zimmerman's SRL cyclical model (i.e., the phase of forethought, the phase of performance and the phase of self-reflection) and revised from Spruce and Bol (2015) instrument. Spruce and Bol's research developed a qualitative protocol to elicit participants' knowledge of SRL in each subcategory at each phase. This study was based on the interview protocol developed by Spruce and Bol, with some revisions according to the content of this study, because Spruce and Bol

studied working teachers who already had some teaching experience. However, this study was focus on the PE college students who were going to be teachers. Some of the original interview questions were for experienced teachers, which was removed or revised in this research. In addition, the research was conducted in mainland China. As a result, some revisions were made in the interview language for the convenience of interviewees. The terms used in the interview questions was taken directly from Zimmerman's SRL model. Interview questions was grouped in phases. First, interviewer was asking participants questions related to above three phases, as well as what they experienced and habits in learning in the past. For instance, "Do you think it is necessary to make a study plan?" and "How do you go through your plan, and would you like study alone or with you peer?" The purpose of these questions was to find out whether the respondent was a planned person.

Another question in performance phase was like "did you used some methods to monitor your learning" and "What is your biggest motivation for learning?" When respondents were asked about their motivation for learning, their state of learning could be learnt. This study modified the interview protocol to make it more consistent with SRL in sports. For example, in the performance phase, questions were like: "Have you ever used self-talk while studying or exercising?" and "What do you think of self-talk?".

In terms of the duration of the interview, it was last about 40 minutes. According to previous research experience, 30-40 minutes could give interviewers and interviewees enough time to think and to communicate, and they were not losing patience because 40 mins were not too long.

The interview was semi-structured. This allowed standard questions to be answered with one or more tailored questions to elicit clarification or validation of the participant's reasoning (Leedy & Ormrod, 2019). The complete interview protocol could be found in Appendix D.

3.3.4. Data Analysis

For the consistency with previous SRL studies (Dignath-van Ewijk & van der Werf, 2012; Spruce & Bol, 2015), this study used an open-ended question to know teachers' knowledge of SRL, and open coding was be made. A deductive and inductive analysis were conducted for the qualitative data. Also, a complementary analysis was carried out for the quantitative data. This study used Tesch (2013) textual data analysis process by reading all transcribe recording (Wilson & Bai, 2010): (1) topics identification; (2) similar topics clustering; (3) topics abbreviation as codes; (4) categories development; (5) topics overlaps and interrelationship; (6) data assembling; (7) preliminary findings analysis; and (8) findings confirmation.

Themes were identified from the follow-up interviews, which provided further explanations about PE pre-service teachers' knowledge, the relationship between teachers' beliefs and knowledge, and the reasons behind the observations.

3.3.4.1 Measuring SRL Knowledge

Firstly, the interviews were primarily pay attention to teachers' cognition of self-regulation strategy and the importance of SRL strategies. The interview questions involved teachers'

knowledge of SRL, learning strategy, and learning habits and was semi-structured. The researcher asked the interviewees some simple questions, including their explanation and understanding of SRL. For example, "What is your view on self-regulated learning? Did you know this concept before? If no, can you imagine what it sounds like? Do you see any connection between self-regulated learning and PE?" Some other questions were like "Is SRL a good strategy? "and "Which student skill can self-regulated learning particularly improve (like performance achievement, planning capability, learning initiative, etc.)?", which correspond to the questions of testing the consistency with SRL beliefs in the questionnaire. The data collected in the questionnaire could be interpreted according to the teachers' description. The idea of coding was following the deign question's philosophy, codes were based on impression on SRL. Also, this section recorded a comparison of their response before and after based on interviewer's the leading questions.

Secondly, Zimmerman's model provided reference for teachers to understand SRL in interviews. More specifically, interview questions and explanation were constructed based on the key stages. Through the analysis of the interview content, the researcher determined the interview theme, interview category and interview agreement. There were three distinct stages of data analysis. The researcher identified the topics based on content. In this section, an inductive approach was used, where the three phases of SRL were predefined. For instance, a question designed wants to know teachers' reflection, "How do you determine your satisfaction with a learning outcome after you complete a learning task?". The interview protocol of this study was

developed based on the research of Spruce and Bol (2015) and was revised according to this study. Therefore, this part was be based on the revised version of the code created by Spruce and Bol. The transcript was encoded by three categories, which were planning, monitoring, and evaluating. These three categories reflected the description and interpretation of the applications of SRL approaches by candidate teachers before entering service. First, in planning phase, when respondents were asked about how they would set goals, the researcher would extract key words from their responses. For example, "planning strategies" was coded when a respondent mentioned keywords like time management, make schedules, and study contents, or when a respondent says he/she wants to proactively learn something to make progress of learning. In addition, when respondents were asked if goal setting was an integral part of the plan and they provided confirmative answers about their long-term goals, short-term goals, "setting goals" was appear in the coding list. Then, in performance section, when respondents were asked about how to implement learning strategies, "monitoring strategies" came up as the next code if they were able to describe what to did, such as checklist, video recording, etc. Also, coding distinguished between self-practice, peer support, or teacher supervision used by the interviewee. Third, in reflection phase, identify the sources of feedback according to the interviewees' descriptions, and determine how to evaluate their own satisfaction. Last but not least, because some of the participants had some internship experience, they were also interviewed about their knowledge while playing the role of teacher. Each step was divided into being a participant as a student and a PE teacher.

Thirdly, participants' knowledge in each stage has been analyzed, and then themes focused more on each participant's answers of regulation learning knowledge in the whole interview. Based on the interviewee's responses, distinguished each participant's reference because might not all participants willing to use each phase of the Zimmerman cyclical model or to use SRL, might some of them preferred to consider of co-regulated learning and external regulated learning. The three phases in Zimmerman's model were a coherent and circular pattern, where planning, performance, and reflection did not exist in isolation. Some combinations were discovered based on the Zimmerman model, i.e., forethought +performance, performance+ reflection, etc. In addition, co-regulated learning and externally regulated learning was also identified in this section.

In summary, one question answer might contain multiple statements, so the researcher classified the answers so that each statement only had one meaning. In addition, open answers were transcribed from the interview recordings and encoded by two encoders according to the coding scheme (Cleary et al., 2022). In order to improve the reliability and consistency of coding, an EdD student who specializes in SRL was invited to review each code. The research team met weekly to discuss the codes and any conflicting opinions were resolved through consultation with the team member, ensuring that each code had only one meaning (Shenton, 2004).

3.3.4.2 The Relationship Between Teachers' Beliefs and Knowledge Regarding SRL

After having taken into account the beliefs and knowledge of Chinese pre-service PE teachers, it was also worthwhile to look at how their beliefs regarding SRL related to their knowledge in this area. As reviewed in Chapter 2, Dignath (2016) stated that when teachers had a greater positive attitude toward SRL practices in schools and they believed that students would actually benefit from using them, they took more steps to create an environment that encouraged the use of SRL strategies. It was important that teachers master relevant knowledge to provide students with superior SRL learning strategies and learning environments. During the interview, interviewees were asked some questions about their explanation of SRL, or daily work use of SRL. First, potential observations were when a student got high score on the survey, he/she could give a clearly describe of definitions or strategies in the interview part. Or when a student got a low score on the survey, he/she might not have had any SRL knowledge before. Second, when a student got a high score on the survey, the interview showed he/she could not give a clear understanding. Or when a student got a low score on the survey, the interview answer showed he/she had knowledge of SRL, but they might not think SRL was a good learning method.

In order to give more accurate results, this part took the scores obtained in the survey to distinguish the participants and to explore the participants' tendencies towards different learning types. This theme combined the quantitative results and qualitative results to analyze the relationship between different levels of belief consistency with SRL and their preferred learning

methods. First, NVivo was employed to search the keywords representing self-regulated learning, co-regulated learning, and externally regulated learning to calculate the word frequency (i.e., the coverage in NVivo) respectively. Thus, the proportion of similar words mentioned by participants in the full text could be obtained. For example, SRL was a type of learning in which learners take an active role in their own learning process. The keywords regarding SRL were independent study, self-study, self- practice. Co-regulated learning involved learners' shared responsibility and mutual support, where two or more individuals learned together to achieve a common learning goal, for which the keywords were classmates, peers, friends, encouragement, and collaboration. Externally regulated learning was a type of learning where an external source controlled the learning process. This external source could be a teacher, a parent, or any other individuals who set the learning goals and decided how the learning will take place, for which the keywords were teachers, parents, coaches, requirements, etc. (de la Fuente et al., 2020). After calculating the word frequencies, the three learning methods were ranked for each interview participant and their mostly preferred methods could be obtained.

Second, the word frequency analysis in above step helped researchers quickly get the insights from a large amount of text. However, it might not be completely accurate to only rely on it because the interviews were semi-structured. The word frequency analysis had several limitations. It was unable to extract the context and figurative meaning of the keywords searched in the text, which could lead to inaccurate conclusions if the keywords were taken out of the context and only the literal meaning was considered (Panadero et al., 2019). Additionally, the

relationships between words or the structure of the text could be missed, leading to important nuances in meaning being overlooked. Lastly, factors such as stop words, stemming, and repetition could affect the accuracy of the word frequency analysis (HaCohen-Kerner et al., 2020). Therefore, the second step involved reading through each interview transcript carefully and checking if any of the above limitations existed and led to inaccurate learning method preferences. If yes, adjustments were made based on the proofreading, to ensure the learning method preferences accurately reflect the interviewees' intended meanings.

3.3.4.3 Sources and Contributing Factors of SRL Beliefs and Knowledge

The second research question was to explore why Chinese pre-service PE teachers present the beliefs and knowledge as shown from RQ1. To answer this research question, interview questions were designed specifically to capture how and how much interviewees obtain beliefs and knowledge from various sources and what factors might influence PE pre-service teachers' beliefs and knowledge of SRL.

As reviewed in Chapter 2, Fives and Buehl (2009) proposed six different sources of beliefs for teachers, which were formal education, formal and informal knowledge systems, observational learning, collaboration with others, personal teaching experiences, and self-reflection. For knowledge, which could come from a variety of sources, including practical experience, daily practice, initial teacher education or professional development, and previous formal education (Calderhead, 1996). During the interview, interviewees were asked about how

they obtain beliefs and knowledge from these sources. An example question about belief sources was "Do you have an experience in which you learnt something all by yourself and achieved good results?" and one about knowledge sources was "What kind of learning method do you think is effective in the learning process?". From respondents' answers, researcher was able to analyze the influence of various sources on them and whether students who obtained beliefs and knowledge from different sources had different levels of SRL belief and knowledge.

Special attention was given to the grade of interviewees because pre-service teachers obtained different levels of formal education and teaching experience in different years. Therefore, they might have totally different sources of beliefs and knowledge. When they were in Year 1 and Year 2, they might be exposed to some basic and theoretical knowledge about pedagogy. However, when students were in the third and fourth years, they might be exposed to higher level educational methods, as well as internship opportunities. Some studies showed that pre-service teachers' beliefs and knowledge were influenced and changed by classroom environment and personal experience in the process of teaching implementation (Seymen, 2012; Yuan & Lee, 2014). In the demographic survey, the grade of the participants and whether they had internship experience were recorded, such that the beliefs and knowledge source change impact could be assessed while pre-service teachers getting senior.

Furthermore, another specific factor that this research was conduct in Mainland China, might different countries have had different learning environment. Most of Chinese students might have pressure in examination, final exam, Zhong Kao, Gao Kao, etc. And in order to get

good test scores, teachers, parents usually made the study plan for students and before students entering college, they might not have more opportunities to decided. Therefore, their sources of beliefs and knowledge might be different for other previous research countries. Also, some PE training program students might be athletes before they joined the programs. And other students might just from public high schools. So, the source might difference.

Chapter 4. Results

This study analyzed Physical Education (PE) pre-service teachers' beliefs and knowledge of Self-Regulated Learning (SRL) and investigated the relationship between teachers' beliefs and knowledge regarding SRL and identified potential influencing factors. A mixed-method approach was employed, incorporating qualitative and quantitative methods in accordance with the research questions. The study utilized the Beliefs about Teaching and Learning 3 (BALT3) (Darmawan et al., 2020) questionnaire to gather responses from 385 PE pre-service teachers, which aimed to explore their beliefs' consistency and inconsistency with SRL in a quantitative way. Based on the relative level of belief consistency with SRL, 20 participants were selected for follow-up interviews, conducted using the Spruce and Bol (2015) interview protocol revised for this study. Qualitative analysis was employed to evaluate the teachers' SRL knowledge. The quantitative and qualitative findings were finally analyzed to explore the relationship between teachers' beliefs and knowledge, as well as the influencing factors, based on the results of both the survey and interviews.

4.1. Quantitative Study: Pre-Services Teacher Survey Results

4.1.1. Descriptive Analysis

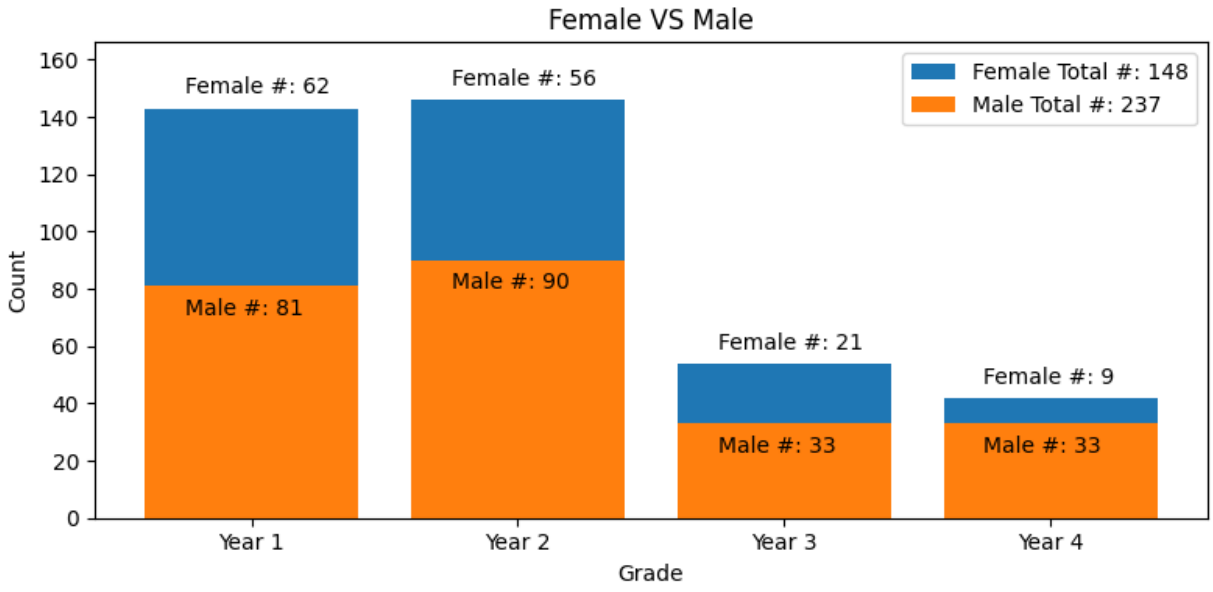
In this section, the survey data were analyzed in a descriptive way by leveraging simple statistics and their plots. A descriptive analysis gave us high-level understanding of the data before digging too much into patterns and significance.

4.1.1.1. Summary of Survey Participant Characteristics

In total, 406 Pre-service PE teachers were tested in the survey. After removing invalidated ones, the responses from 385 participants were analyzed by descriptive methods and the partial credit model. The questionnaire sample included participants from six universities, which were chosen for two crucial reasons. First, the six universities all have offered PE programs and included compulsory PE courses, such as Pedagogy, Sports Science, Sports Psychology, etc. Also, they have set a practicum before students' graduation.

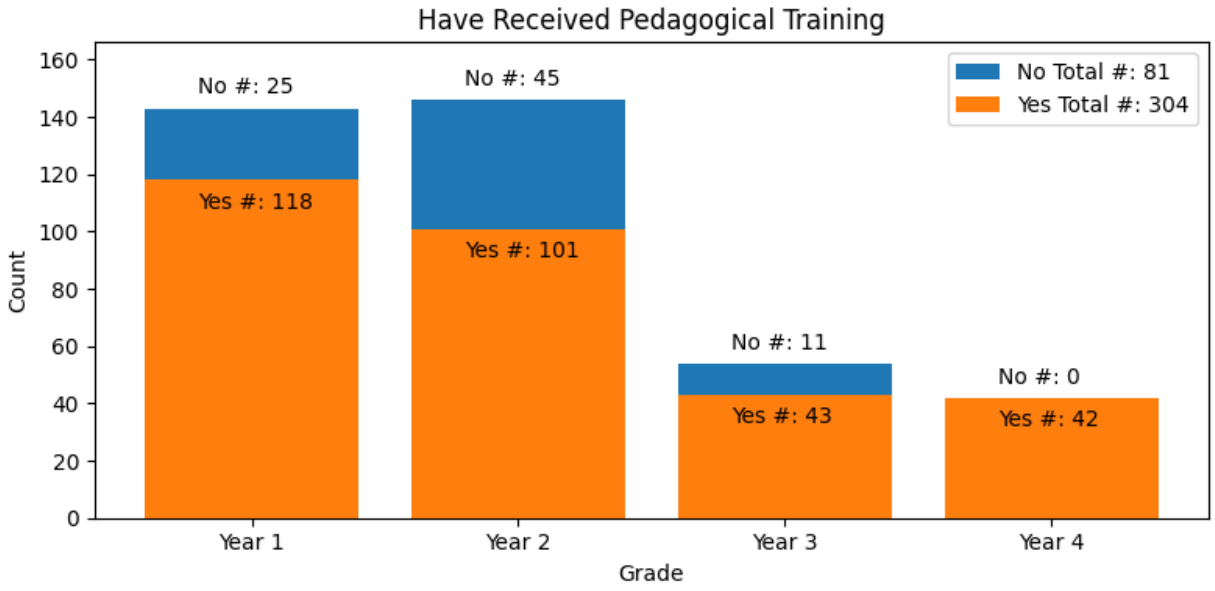
Among the 385 participants, the ratios between females and males varied a lot in different years, as shown in Figure 6. In general, there were fewer female participants tested in the survey. In Year 3 and Year 4, most of the participants were males.

Figure 6 *Gender of Survey Participants in Different Grades*



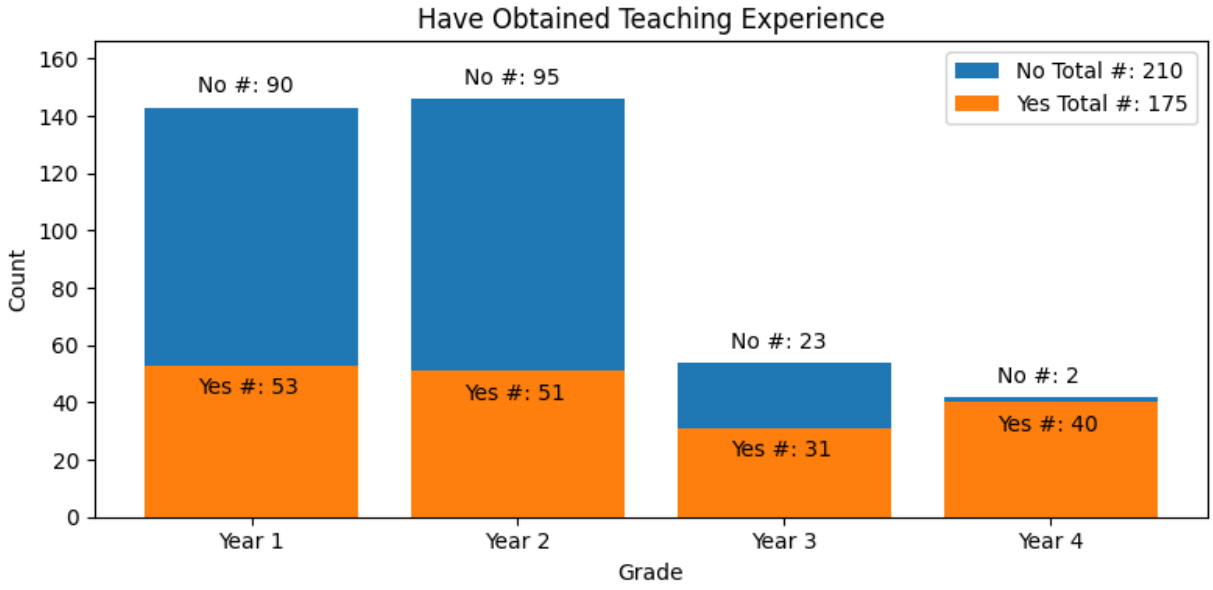
In Figure 7, it was shown the counts of how many participants have received pedagogical training. In total, 304 participants (i.e., 79%) have received pedagogical training when they participated in the survey. Comparing to the participants from junior grades, the ratio was significantly higher for senior participants. All of the Year 4 participants had received pedagogical training.

Figure 7 *Learning Experiences of Participants in Different Grades*



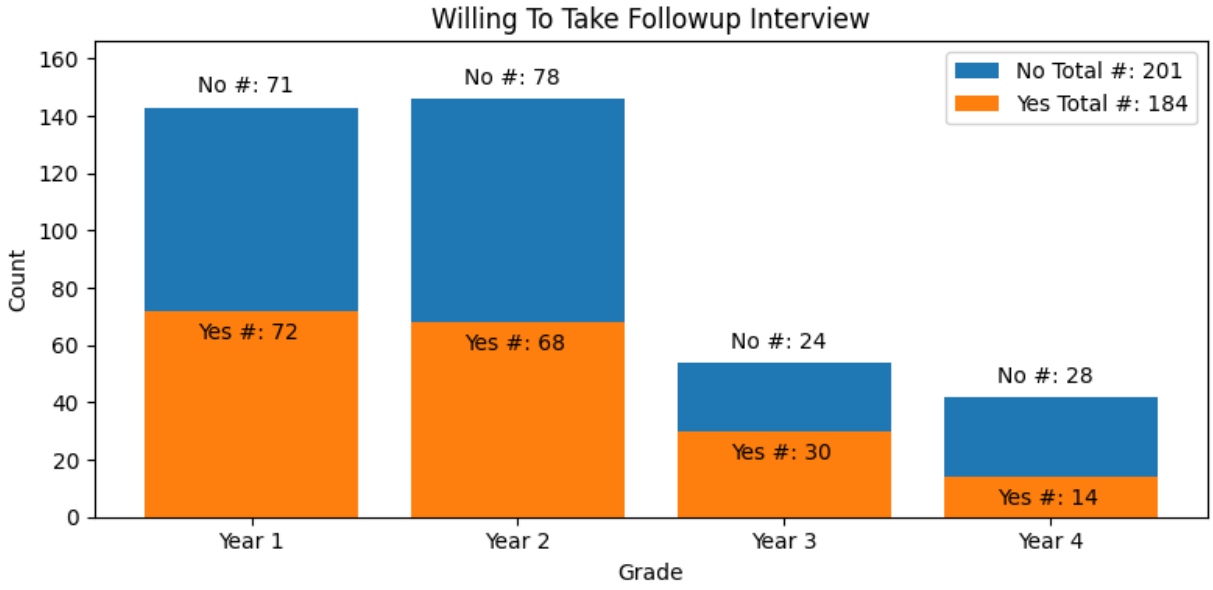
In Figure 8, 175 of the participants had obtained teaching experience is illustrated, and 210 had not obtained. There was a significant upside trend of getting more teaching experience as participants become more senior. Most of junior participants reported no teaching experience, mainly because junior students usually spent most of their time in classrooms. For the participants from senior grades, they usually had more time for internships and were able to attend the teaching practice programs organized by colleges.

Figure 8 *Teaching Experience of Participants With/Without Teaching Experience*



In Figure 9, it described 184 participants who were willing to participate in the follow-up interviews after the survey. In general, less than half of participants were willing to do so and the ratios were lower for the senior participants, compared to the junior participants. This was understandable because senior students had the pressure of seeking for jobs and applying for master programs. Junior students showed that they had more free time to be able to be interviewed to know better about their responses.

Figure 9 *Follow-up Interview Willingness of Participants in Different Grades*



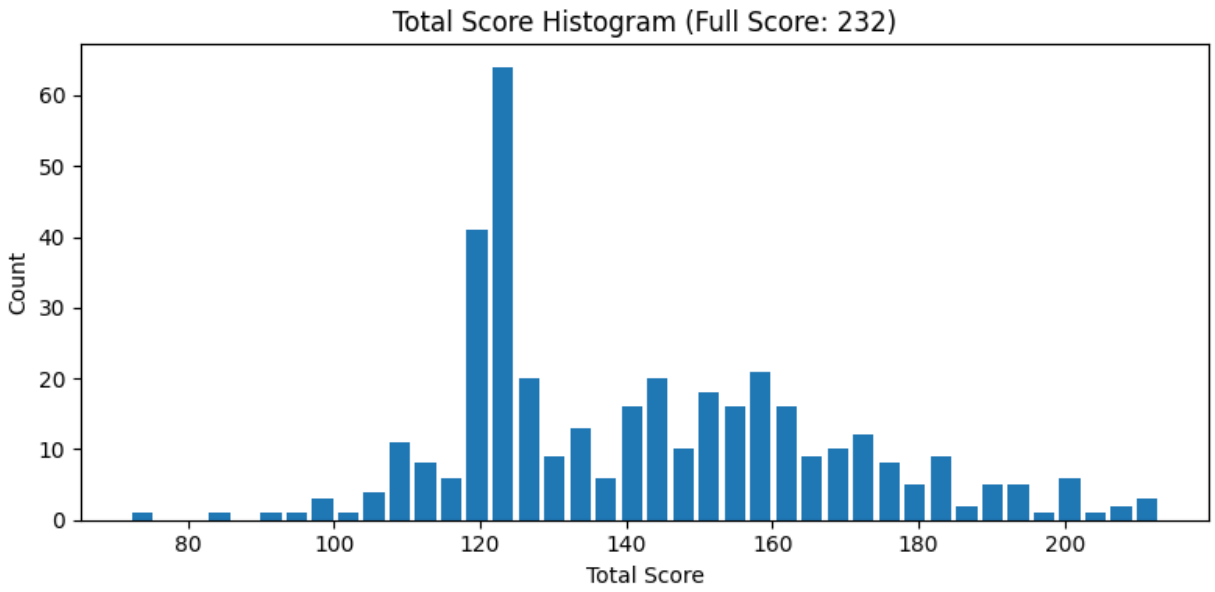
4.1.1.2. Summary of Survey Answer Characteristics

Since the survey used a five-point Likert scale, every participant was given a total score, which represented his/her overall beliefs consistency with SRL. To do so, their answers to some items that were inconsistent with SRL must be reverted. In other words, for the items consistent with SRL, Strongly Disagree, Disagree, Neutral, Agree and Strongly Agree were assigned scores of 0, 1, 2, 3 and 4. For the inconsistent items, Strongly Disagree, Disagree, Neutral, Agree and Strongly Agree were assigned scores of 4, 3, 2, 1 and 0 on the other hand. As a result, the highest consistency with SRL shown by a participant in an item always got the highest score. Note that the data after the aforementioned pre-processed step was used in all following analysis from here.

Figure 10 talked about the distribution of the total scores of all participants. There had three observations. First, the distribution was positively skewed in some degree, and 53.5% of the participants obtained lower scores than the average score of 142.69. There were a small portion of participants who obtain super high scores, i.e., 13.24% of the participants obtained scores higher than or equal to 174. Second, a cluster of total scores was found at around 120, which was understandable. There were 58 items in total and choosing Neutral obtained a score of 2. As a result, the neutral total score was 116 and some participants might not like to choose extreme points, which might explain why there was a cluster. Last but not least, comparing to the neutral total score of 116, 91.42% of the participants achieved higher scores, showing that most of the

participants' beliefs agreed with SRL in some degree. However, it could not tell the meaning and significance of the absolute level of a score. For example, there was not more information about the difference between the beliefs of a participant who got a total score of 100 and the beliefs of another participant with a total score of 150, in terms of their beliefs' consistency with SRL, than the very straightforward conclusion that the participant with a total score 150 agreed more on SRL than the participant of 100 did. This topic would be revisited after applying the partial credit model to the data. The model could translate the total scores into person abilities, which were latent variable values estimated by it. Then the difference between person abilities of different participants could be associated with the potentially different answers to items that the model believed they might make.

Figure 10 *Survey Total Score Histogram*

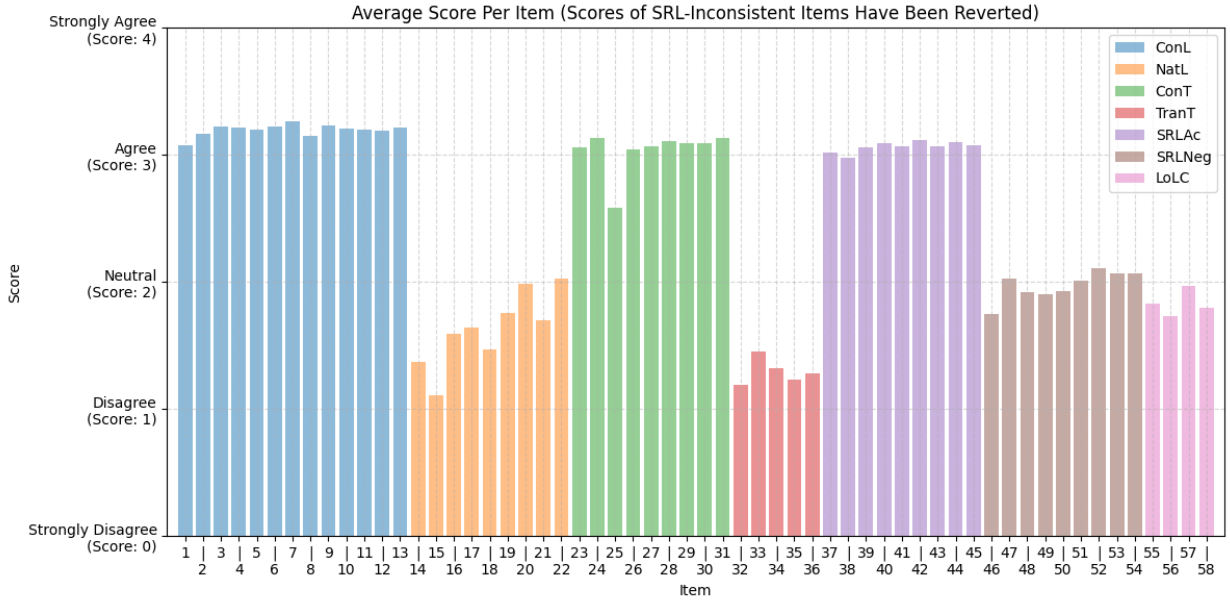


In Figure 11 Survey Average Score Per Item, the average scores of all items were shown. There were seven sections, and it showed clear trends of the scores in different sections.

In total, BALT3 (Darmawan et al., 2020) concluded seven factors that might influence teachers' consistent or inconsistent beliefs with SRL. The survey participants gave higher scores to the items from the SRL-consistent sections but lowers scores to the SRL-inconsistent items on average. This phenomenon was the same as what observed in the original BALT research (Darmawan et al., 2020).

For the three SRL-consistent sections, the per-item average scores indicated that the participants chose Agree as a whole, and their choices were relatively consistent among the three sections. For the four SRL-inconsistent sections, TranT saw the lowest scores among all seven sections, NatL contained the most diverse scores ranging from Disagree to Neutral, and SRLNeg and LoLC were chose to be neutral by participants. Generally speaking, items in the same section shared similar average scores except NatL, and no item had an extreme average score that was close to 0 or 4.

Figure 11 *Survey Average Score Per Item*



4.1.2. Rasch Model Analysis

The partial credit model described in Section 3.2.4.1 Rasch Modelling

Georg Rasch initially developed the classic Rasch model in 1980 (Rasch, 1993). The model was designed for modelling and analyzing dichotomous data such as right/wrong answers in surveys (Von Davier & Molenaar, 2003). The polytomous Rasch model was an enhancement of the dichotomous Rasch model. It was a statistical model of measurements, and it had potential applications to any data collected in processes of measuring willingness and/or capability (Andrich, 1978). Usually, the data to be modelled were responses to items that had successively increased integer scores. For instance, the model could be deployed to analyze items for assessing educational items that use Likert scales. In this case, higher integer scores represent higher degrees of agreement, competence, understanding, and attainment.

Rasch modelling is suitable for analyzing the data collected in the survey of this study. First, the survey adopted the five-point Likert scale, which is a kind of measures that can be modelled by the Rasch model. Second, the original paper of BALT3 adopted the Rasch model to analyze the responses to BALT3 and discussed and confirmed about the validity of doing so (Darmawan et al., 2020). Third, the Rasch model has been used and developed for tens of years, since its invention. Many academic papers in the field of education adopted the Rasch model to analyze questionnaires based on Likert scales, which demonstrated the validity of the Rash model (Darmawan et al., 2020; Lombaerts et al., 2009; Vosniadou et al., 2020).

3.2.4.2. Partial Credit Model was applied to the data summarized in the previous section with the help of the package called Test Analysis Modules, i.e., TAM, in the statistical programming language of R. The package used marginal maximum likelihood estimation to estimate the parameters in multidimensional item response models like the partial credit model. As a result, the package was based on

$$P[X_{ni} = x] \propto exp(b_{ix}\theta_n + a_{ik}\xi), \quad (3)$$

where $n = 1, 2, \dots, N$, $i = 1, 2, \dots, Q$, $k = 0, 1, 2, \dots, M$ and $x = 0, 1, 2, \dots, M$, assuming there were N participants, Q items and M points. In the equation, the denominator on the right-hand side was ignored, given that only the numerator decides the probability after being normalized. Therefore, the partial credit model described in Equation（ 1 ）and Equation（ 2 ）represents a

special case of Equation（ 3 ）. Details could be found in Wilson and Wu (1997) and Adams and Wu (2007) (Adams et al., 1997; Adams & Wu, 2007).

4.1.2.1. Model Selection Between Partial Credit Model and Rating Scale Model

To be begin with, this research compared the partial credit model and the rating scale model in terms of their performance of fitting to the data. This was done by comparing multiple metrics in Table 4. They covered different perspectives of the fitting performance of the two models.

Table 4 *Fitting Performance Comparison Between Partial Credit Model and Rating Scale Model*

Metric	Partial Credit Model	Rating Scale Model
Number of Parameters	233	62
Log Likelihood (i.e., LL)	-28860.45	-29494.12
AIC	58187.00	59112.00
AIC3	58420.00	59174.00
BIC	59108.00	59357.00
aBIC	58366.00	59160.00
CAIC	59341.00	59419.00
AICc	58909.00	59136.00
GHP	1.30	1.32

Outfit MS Participant Count in $[0.5, 1.5]$	228	221
Outfit MS Participant Count in $[0.0, 2.0]$	363	362

The partial credit model had substantially more parameters than the rating scale model, as shown in Table 4, because different items had different sets of item threshold parameters. From the log likelihood perspective, the partial credit model fitted the data better than the rating scale model did. The log likelihood represented how model predictions were close to the data. The higher the log likelihood was, the better a model fitted a dataset.

Then the estimated values of AIC, AIC3, BIC, aBIC, CAIC, AICc and GHP were shown in Table 4. They were all estimators of prediction errors of models, with the trade-off between goodness of fitting and model complexity being considered. The trade-off was important because a model could always increase its fitting performance if it had more parameters, which was termed over-fitting in statistics in extreme scenarios. And the worst scenario was that the model with too many parameters could remember every datapoint in a dataset without capturing any patterns between independent variables and dependent variables. So, these prediction error estimators could be employed for selecting models. The lower their estimated values were, the better a model fitted a dataset and the less complicated it was.

Table 5 *Definitions of Prediction Error Estimators (Robitzsch et al., 2022)*

Estimator	Full Name	Brief Equation
AIC	Akaike Information Criterion	$AIC = -2 * LL + 2 * p$
AIC3	Akaike Information Criterion with Coefficient of 3	$AIC3 = -2 * LL + 3 * p$
BIC	Bayesian Information Criterion	$BIC = -2 * LL + \log n * p$
aBIC	Adjusted Bayesian Information Criterion	$aBIC = -2 * LL + \log \frac{n-2}{24} * p$
CAIC	Consistent Akaike Information Criterion	$CAIC = -2 * LL + (\log n + 1) * p$
AICc	Bias Corrected Akaike Information Criterion	$AICc = -2 * LL + 2 * p + \frac{2 * p * (p+1)}{n-p-1}$
GHP	Gilula-Haberman Log Penalty	$GHP = \frac{(-LL + p)}{N * Q}$

In Table 5, a brief summary of the prediction error estimators used in Table 4 was presented. In the equations, LL denoted log likelihood and p referred to penalty. The table was meant for a brief understanding about how they work and what was the difference between them. Note that the calculation of the penalty terms in different prediction error estimators could be different. The details were ignored here because these terms all share the same purpose of penalizing complicated models, and their equations could be found easily online.

Back in Table 4, the partial credit model had lower estimated values of AIC, AIC3, BIC, aBIC, CAIC, AICc and GHP, compared to the rating scale model. Note that the partial credit model had much more parameters to estimate than the rating scale model, which might cause

prediction error estimators to go higher in general. So, at the higher price of model complexity, the partial credit model achieved even higher goodness of fitting, so it was worth the higher complexity to fit the data better.

Last but not least, outfit means of squares were also included in Table 4. To compare the two models efficiently, the table also included the numbers of participants with outfit means of squares within two intervals, i.e., $[\mathbf{0.5}, \mathbf{1.5}]$ and $[\mathbf{0.0}, \mathbf{2.0}]$. Outfit means of squares could be used to measure the mis-fitting between models and the dataset. The higher a participant's outfit mean of squares by a model was, the more likely the model thought it was an outlier. So, given a fixed interval, the more participants had outfit means of squares by a model within it, the better the model fitted the dataset. The partial credit model outperformed the rating scale model in this sense.

4.1.2.2 Parameter Estimation Related to Item Difficulty

In this section, the estimation of the parameters related to item difficulty was examined, including the estimated values and the associated standard errors. As discussed, in at the beginning of Section 4.1.2. Rasch Model Analysis, TAM used a generalized formulation (Equation (3)), of which the partial credit model (described in Equation (1) and Equation (2)) was a special case. The connection between the two formulations was given by

$$\delta_i = \sum_{k=1}^{M} \xi_{ki}$$

for the item difficulty of the i'th item and

$$\tau_{ki} = \xi_{ki} - \delta_i$$

for the k'th item threshold between the $(k-1)$'th item point and the k'th item point of the i'th item. In other words, TAM estimated ξ_{ki} for all item and calculated the item difficulty and thresholds according to the above formulas. As a result, TAM only estimated the standard errors of ξ_{ki}. The results were reported in Table 6.

Table 6 *Parameter Estimation Table of Item Difficulty*

Item	δ_i	τ_{1i}	ξ_{1i}(SE)	τ_{2i}	ξ_{2i}(SE)	τ_{3i}	ξ_{3i}(SE)	τ_{4i}	ξ_{4i}(SE)
q1	-0.865	1.028	0.163(0.225)	-0.826	-1.691(0.188)	-0.899	-1.764(0.137)	0.698	-0.167(0.108)
q2	-0.913	1.176	0.262(0.235)	-0.568	-1.481(0.199)	-1.323	-2.237(0.152)	0.715	-0.198(0.107)
q3	-0.928	1.533	0.604(0.226)	-0.634	-1.562(0.199)	-1.376	-2.304(0.157)	0.478	-0.451(0.106)
q4	-0.93	1.489	0.559(0.230)	-0.723	-1.653(0.202)	-1.315	-2.245(0.156)	0.548	-0.382(0.106)
q5	-0.95	1.276	0.326(0.241)	-0.766	-1.716(0.205)	-1.09	-2.040(0.151)	0.58	-0.369(0.106)
q6	-0.968	1.372	0.404(0.247)	-0.809	-1.777(0.212)	-1.161	-2.130(0.155)	0.598	-0.371(0.106)
q7	-0.989	1.257	0.268(0.247)	-0.396	-1.385(0.209)	-1.361	-2.351(0.162)	0.5	-0.489(0.106)
q8	-0.922	1.385	0.463(0.241)	-1.117	-2.039(0.209)	-0.981	-1.903(0.145)	0.713	-0.209(0.107)
q9	-0.973	1.874	0.901(0.254)	-1.36	-2.333(0.230)	-1.226	-2.199(0.160)	0.712	-0.261(0.106)
q10	-0.966	1.649	0.683(0.253)	-1.288	-2.254(0.225)	-1.075	-2.041(0.154)	0.714	-0.252(0.106)
q11	-0.953	1.694	0.741(0.247)	-1.301	-2.254(0.221)	-1.075	-2.028(0.153)	0.683	-0.270(0.106)
q12	-0.961	1.01	0.050(0.247)	-0.566	-1.527(0.202)	-1.036	-1.997(0.149)	0.592	-0.369(0.106)
q13	-0.957	1.515	0.558(0.247)	-0.893	-1.850(0.216)	-1.314	-2.272(0.159)	0.692	-0.265(0.106)
q14	0.236	-0.722	-0.486(0.119)	-0.194	0.042(0.112)	0.478	0.715(0.146)	0.438	0.675(0.219)
q15	0.374	-0.83	-0.456(0.112)	0.479	0.853(0.125)	0.3	0.674(0.167)	0.051	0.425(0.235)
q16	0.047	-0.454	-0.407(0.122)	0.052	0.099(0.112)	-0.102	-0.055(0.125)	0.505	0.552(0.175)
q17	0	-0.393	-0.393(0.121)	0.283	0.283(0.113)	-0.355	-0.355(0.122)	0.466	0.466(0.164)
q18	0.144	-0.588	-0.444(0.118)	0.348	0.492(0.114)	-0.395	-0.251(0.129)	0.634	0.778(0.191)
q19	-0.064	-0.382	-0.446(0.125)	0.281	0.217(0.112)	-0.427	-0.491(0.118)	0.528	0.463(0.157)
q20	-0.196	-0.145	-0.341(0.129)	0.31	0.114(0.114)	-0.674	-0.870(0.114)	0.51	0.314(0.140)
q21	-0.005	-0.447	-0.452(0.125)	0.027	0.023(0.112)	-0.247	-0.251(0.120)	0.666	0.661(0.170)
q22	-0.23	-0.175	-0.405(0.133)	0.146	-0.083(0.114)	-0.461	-0.690(0.114)	0.489	0.260(0.139)
q23	-0.884	0.761	-0.124(0.246)	-0.769	-1.653(0.195)	-0.927	-1.811(0.137)	0.935	0.051(0.110)

q24	-0.955	1.049	0.094(0.268)	-1.059	-2.014(0.220)	-0.91	-1.865(0.144)	0.92	-0.035(0.108)
q25	-0.634	-0.446	-1.080(0.195)	-0.026	-0.661(0.130)	-0.21	-0.845(0.112)	0.682	0.048(0.121)
q26	-0.918	0.389	-0.528(0.260)	-0.564	-1.482(0.190)	-0.715	-1.633(0.132)	0.89	-0.028(0.110)
q27	-0.899	0.718	-0.182(0.253)	-0.755	-1.654(0.198)	-0.918	-1.817(0.138)	0.955	0.056(0.110)
q28	-0.956	0.664	-0.292(0.277)	-0.684	-1.640(0.212)	-1.005	-1.961(0.144)	1.025	0.069(0.109)
q29	-0.952	0.42	-0.532(0.277)	-0.472	-1.424(0.201)	-0.963	-1.915(0.141)	1.015	0.063(0.110)
q30	-0.88	1.346	0.467(0.240)	-1.264	-2.144(0.208)	-1.003	-1.883(0.141)	0.921	0.042(0.109)
q31	-0.96	1.118	0.158(0.277)	-1.134	-2.094(0.229)	-1.02	-1.980(0.148)	1.036	0.076(0.109)
q32	0.349	-1.126	-0.777(0.117)	0.708	1.057(0.124)	-0.157	0.192(0.155)	0.576	0.925(0.249)
q33	0.203	-0.676	-0.473(0.120)	-0.122	0.081(0.111)	0.049	0.252(0.134)	0.749	0.952(0.214)
q34	0.243	-1	-0.757(0.120)	0.437	0.680(0.116)	-0.031	0.212(0.144)	0.595	0.838(0.223)
q35	0.341	-1.159	-0.818(0.119)	0.424	0.765(0.119)	0.127	0.467(0.157)	0.608	0.949(0.254)
q36	0.292	-1.02	-0.728(0.119)	0.152	0.443(0.115)	0.463	0.755(0.156)	0.406	0.698(0.238)
q37	-0.878	0.926	0.048(0.260)	-1.302	-2.180(0.212)	-0.739	-1.617(0.132)	1.115	0.237(0.113)
q38	-0.892	0.368	-0.524(0.268)	-0.902	-1.794(0.195)	-0.519	-1.411(0.126)	1.054	0.162(0.113)
q39	-0.922	0.903	-0.019(0.268)	-1.242	-2.164(0.216)	-0.665	-1.587(0.134)	1.004	0.081(0.111)
q40	-0.917	1.366	0.449(0.260)	-1.55	-2.467(0.224)	-0.796	-1.713(0.139)	0.981	0.064(0.110)
q41	-0.943	0.78	-0.164(0.286)	-1.094	-2.037(0.224)	-0.859	-1.803(0.139)	1.173	0.230(0.112)
q42	-0.921	1.214	0.293(0.260)	-1.143	-2.064(0.220)	-1.09	-2.012(0.147)	1.019	0.097(0.110)
q43	-0.899	0.657	-0.243(0.260)	-0.621	-1.520(0.201)	-1.127	-2.027(0.142)	1.092	0.193(0.111)
q44	-0.919	1.014	0.095(0.268)	-0.951	-1.870(0.220)	-1.207	-2.125(0.149)	1.144	0.225(0.111)
q45	-0.913	0.691	-0.221(0.268)	-0.637	-1.550(0.208)	-1.205	-2.118(0.146)	1.151	0.238(0.112)
q46	-0.048	-0.645	-0.693(0.132)	-0.043	-0.091(0.111)	-0.002	-0.050(0.120)	0.691	0.643(0.172)
q47	-0.218	-0.318	-0.536(0.137)	0.062	-0.155(0.114)	-0.417	-0.635(0.113)	0.673	0.456(0.145)
q48	-0.163	-0.526	-0.688(0.136)	0.113	-0.050(0.112)	-0.277	-0.440(0.115)	0.69	0.527(0.154)
q49	-0.175	-0.575	-0.749(0.136)	0.262	0.087(0.112)	-0.293	-0.468(0.116)	0.606	0.431(0.151)
q50	-0.17	-0.392	-0.562(0.132)	0.351	0.182(0.113)	-0.562	-0.731(0.115)	0.602	0.433(0.147)
q51	-0.241	-0.47	-0.711(0.140)	0.207	-0.034(0.113)	-0.3	-0.541(0.114)	0.563	0.321(0.143)
q52	-0.277	-0.269	-0.546(0.139)	0.249	-0.028(0.115)	-0.566	-0.843(0.113)	0.586	0.309(0.137)
q53	-0.267	-0.302	-0.569(0.139)	0.021	-0.246(0.114)	-0.2	-0.467(0.113)	0.482	0.215(0.139)
q54	-0.239	-0.278	-0.517(0.138)	0.041	-0.198(0.114)	-0.466	-0.705(0.112)	0.703	0.465(0.143)
q55	-0.137	-0.73	-0.866(0.139)	0.029	-0.108(0.111)	0.162	0.025(0.119)	0.539	0.402(0.161)
q56	-0.077	-0.763	-0.840(0.134)	0.148	0.071(0.111)	0.106	0.028(0.122)	0.509	0.432(0.167)
q57	-0.221	-0.454	-0.675(0.137)	0.144	-0.076(0.113)	-0.178	-0.398(0.115)	0.487	0.266(0.144)
q58	-0.136	-0.797	-0.933(0.137)	0.32	0.184(0.111)	-0.025	-0.161(0.120)	0.502	0.366(0.159)

As shown in Table 6, 56 items had disordered/non-ordinal threshold estimates. This phenomenon has been shown to be non-harmful, because it did not violate the assumptions of the

partial credit models (Adams & Wu, 2007). Later on, in Section 4.1.2.4. Relationship between Item Difficulty and Person Ability, Thurstonian thresholds have been shown to illustrate the cutoff points between the different levels of person abilities that were predicated to lead to potentially different item points. In addition, Table 6 also showed that all items had significantly non-zero ξ estimates, which approved the validity of adopting the partial credit model to analyze the responses collected in the survey.

The outfit and infit means of squares and their standardized values were examined. Two items' results were highlighted in Table 7, because they had very dispersed observations and consequently very high estimated values. The rest of the items mostly had the estimated values below 2.0. Note that the outfit and infit means of squares measure how the observations were dispersed from the expectations from the partial credit model in this case. For example, given an item, the participants with the person abilities higher than the difficulty of the item were generally expected to choose higher points, and vice versa. This did not hold, if the fitting statistics of the item were high.

Table 7 *Fitting Statistics of The Two Items with The Most Dispersed Observations*

Item	Point	Outfit MS	Outfit_T	Infit MS	Infit_T
25	1	13.586	27.649	1.101	0.701
25	2	3.568	24.738	1.374	5.26
25	3	1.793	16.8	1.5	11.322
25	4	1.527	8.043	1.287	4.664
38	1	15.709	19.322	1.015	0.139

38	2	6.195	16.66	1.061	0.446
38	3	1.386	5.47	1.098	1.516
38	4	1.204	4.216	1.127	2.686

4.1.2.3. Parameter Estimation Related to Person Ability

In this section, the estimation of the parameters related to person ability was reported. TAM could directly provide the estimated values and the associated standard errors of the participants' person ability.

Table 8 *Parameter Estimation of Person Ability of Lowest 10 Participants*

Person ID	β_n	SE	Outfit MS	Outfit T	Infit MS	Infit T
205	-1.203	0.110	1.369	1.807	1.673	4.275
128	-1.048	0.110	0.762	-1.354	0.555	-3.509
157	-0.975	0.111	1.799	3.590	1.366	2.090
163	-0.926	0.112	0.846	-0.818	0.817	-1.103
288	-0.901	0.112	5.301	12.087	4.363	11.089
158	-0.876	0.112	0.781	-1.211	0.605	-2.567
349	-0.863	0.113	2.383	5.447	2.064	4.670
234	-0.838	0.113	0.525	-3.016	0.499	-3.370
313	-0.812	0.114	1.843	3.639	1.779	3.507
104	-0.786	0.114	1.111	0.625	0.913	-0.415

Table 9 *Parameter Estimation of Person Ability of Highest 10 Participants*

Person ID	β_n	SE	Outfit MS	Outfit T	Infit MS	Infit T
224	0.909	0.177	1.210	0.849	1.948	3.042
19	0.940	0.180	0.786	-0.809	0.984	0.022
70	0.940	0.180	0.853	-0.511	1.212	0.860
204	0.940	0.180	0.853	-0.512	1.286	1.111
47	1.007	0.186	1.230	0.902	2.378	3.893
188	1.078	0.192	1.623	2.058	2.687	4.386
136	1.115	0.196	0.916	-0.232	1.068	0.332
295	1.237	0.208	1.329	1.164	2.573	3.893
153	1.327	0.218	1.573	1.803	3.131	4.662
211	1.376	0.223	1.280	0.983	1.808	2.209

Since the analysis included 385 survey participants, only the highest and lowest 10 participants were shown in Table 8 and Table 9. The second column presented the estimated person ability, which was an indicator of a participant's beliefs consistency with SRL. The partial credit model believed Participant No. 205 was the most likely one whose belief was inconsistent with SRL, but Participant No. 211's beliefs agreed the most with SRL, after considering their responses to all items.

The standard errors of the estimated values were also included in the tables. Among the 385 participants, there were 255 of them whose person ability estimates were significantly non-zero, meaning they might have more significant consistent or inconsistent beliefs with SRL comparing to their non-significant counterparties, which was another evidence behind the validity of the

partial credit model applied to the response collected in the survey. This could be more meaningfully visualized by the Wright plots between person ability and item difficulty, to be discussed in Section 4.1.2.4. Relationship between Item Difficulty and Person Ability.

Last but not least, the Outfit/Infit means of squares statistics and standardized statistics were shown in the tables. Both could be used to measure how well the partial credit model fitted the data. The Outfit ones were more sensitive to outlier participants, while the Infit ones were more sensitive to overfitting participants. For example, Participant No. 205 had an Outfit mean of squares of 1.369, which was within the range of 0.5 to 1.5 and was believed to be productive in the measurement analysis. The same applied to the participant's standard statistic, which was 1.807. The value was within the range of -1.9 to 1.9, which was believed to be reasonably predicted by the model (*Sample Size and Item Calibration [or Person Measure] Stability*, 2022). Though the participant did not seem to be an outlier based on the Outfit statistics, the Infit statistics indicated that he/she might not be well predicted by the model, which showed the existence of noise. But this seemed to be better than Participant No. 128, because his/her Infit statistics were very low and could be indicators of being an inlier.

In Figure 12 to Figure 15, the person ability estimates of the participants of different conditions were examined. To better assist the visualization, various statistical tests for comparing distributions were employed in Table 10, and significantly different person ability histograms were highlighted by stars.

The first observation was that gender was not related to person ability. In other words, male and female pre-service teachers did not tend to have different degrees of beliefs consistency with SRL. The second observation was that pre-service teachers in different years have significantly different levels of beliefs consistency with SRL. Senior students from Year 4 and Year 3 have beliefs that were significantly more consistent with SRL, comparing to junior students from Year 2 and Year 1. With this being said, learning seemed to be positively related to students' improvement of their beliefs on SRL. Thirdly, the statistical tests had different views on the association of teaching experience with person ability. Also, only two tests showed the lowest amount of significance. This probably indicated the complex link between teaching experience and beliefs. Lastly, receiving pedagogical training was significantly helpful for helping students gain more SRL-consistent beliefs.

Figure 12 *Person Ability Comparison Between Participants of Different Genders*

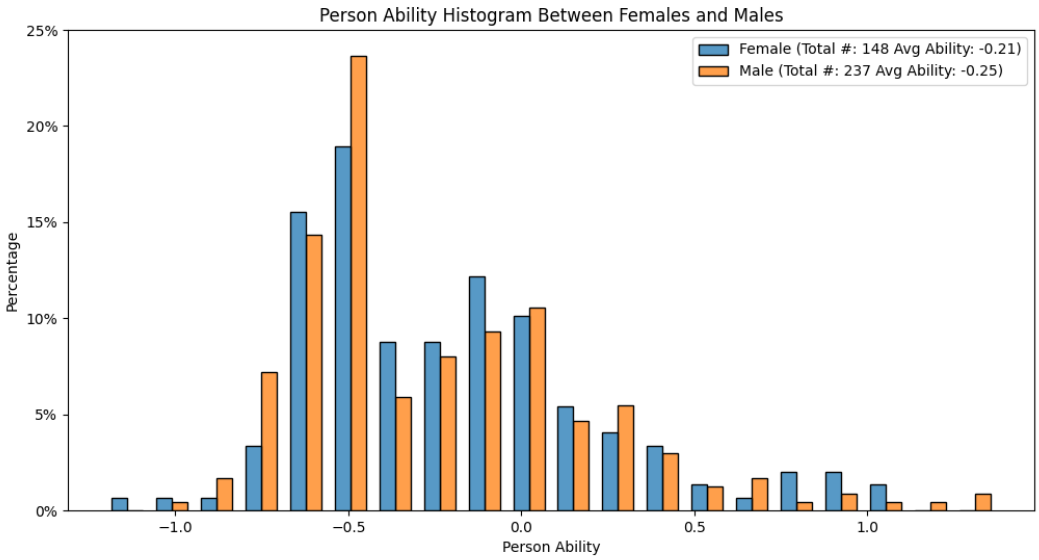


Figure 13 *Person Ability Comparison Between Participants in Different Grades*

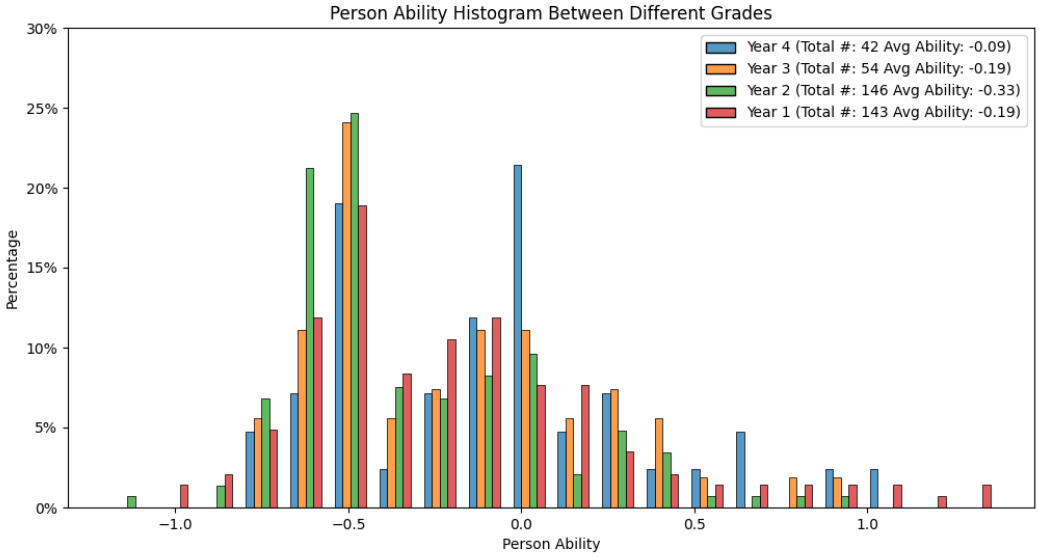


Figure 14 *Person Ability Comparison Between Participants With/Without Teaching Experience*

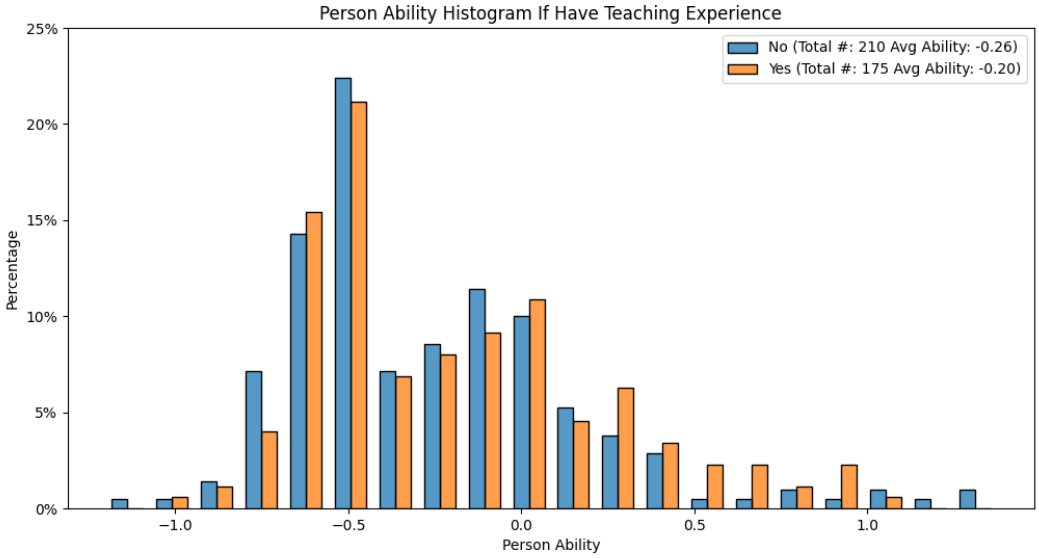


Figure 15 *Person Ability Comparison Between Participants Who Learned/Did Not Receiving Pedagogical Training*

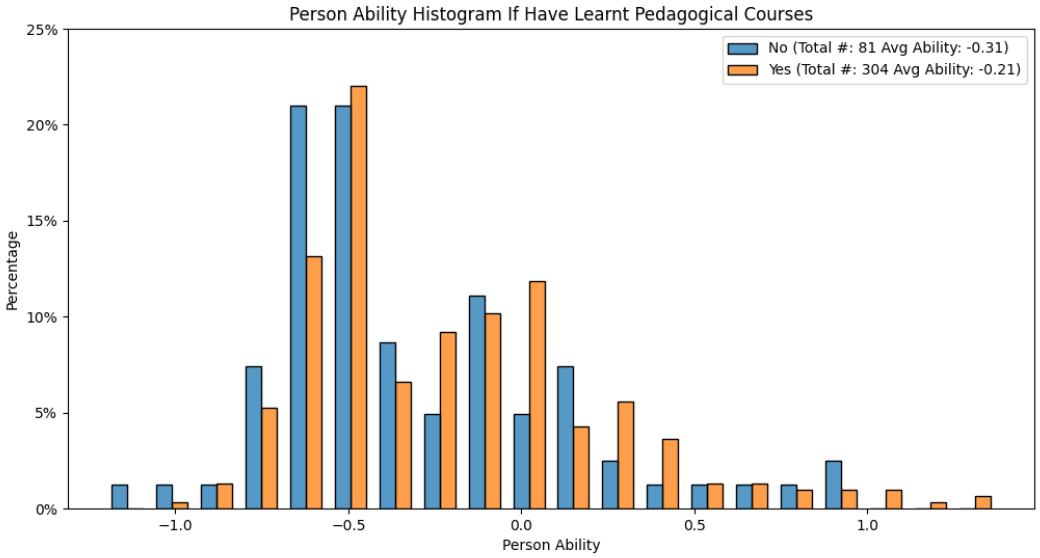


Table 10 *Statistical Tests of Person Ability Difference Driven by Conditions*

Condition	*F*	*G*	Statistical Test	Statistic	P Value	Significance Code
Gender	Male	Female	Wilcoxon–Mann–Whitney Test	16508	0.331738951	
Gender	Male	Female	Brunner-Munzel Test	0.974969367	0.330311394	
Gender	Male	Female	Kolmogorov-Smirnov Test	0.075607253	0.63882994	
Grade	Year 4	Year 3	Wilcoxon–Mann–Whitney Test	1257	0.182612027	
Grade	Year 4	Year 2	Wilcoxon–Mann–Whitney Test	4090	0.000478481	***
Grade	Year 4	Year 1	Wilcoxon–Mann–Whitney Test	3483.5	0.057700512	*
Grade	Year 3	Year 2	Wilcoxon–Mann–Whitney Test	4842	0.006544682	***
Grade	Year 3	Year 1	Wilcoxon–Mann–Whitney Test	4025	0.323346762	
Grade	Year 2	Year 1	Wilcoxon–Mann–Whitney Test	8618.5	0.994889723	
Grade	Year 4	Year 3	Brunner-Munzel Test	-0.905863834	0.183729149	
Grade	Year 4	Year 2	Brunner-Munzel Test	-3.513029945	0.000400043	***
Grade	Year 4	Year 1	Brunner-Munzel Test	-1.619044961	0.054906477	*
Grade	Year 3	Year 2	Brunner-Munzel Test	-2.545971525	0.006251061	***

Grade	Year 3	Year 1	Brunner-Munzel Test	-0.463108394	0.322145518	
Grade	Year 2	Year 1	Brunner-Munzel Test	2.602180944	0.995126548	
Grade	Year 4	Year 3	Kolmogorov-Smirnov Test	0.182539683	0.1817655	
Grade	Year 4	Year 2	Kolmogorov-Smirnov Test	0.31409002	0.001157866	***
Grade	Year 4	Year 1	Kolmogorov-Smirnov Test	0.221778222	0.034366119	**
Grade	Year 3	Year 2	Kolmogorov-Smirnov Test	0.233891426	0.010906719	**
Grade	Year 3	Year 1	Kolmogorov-Smirnov Test	0.065915566	0.674524219	
Grade	Year 2	Year 1	Kolmogorov-Smirnov Test	0.02811572	0.869100277	
Teaching Experience	Yes	No	Wilcoxon–Mann–Whitney Test	19836	0.089273987	*
Teaching Experience	Yes	No	Brunner-Munzel Test	-1.345625932	0.089630841	*
Teaching Experience	Yes	No	Kolmogorov-Smirnov Test	0.083809524	0.247080682	
Pedagogical Training	Yes	No	Wilcoxon–Mann–Whitney Test	14228	0.015564958	**
Pedagogical Training	Yes	No	Brunner-Munzel Test	-2.12901391	0.017661584	**
Pedagogical Training	Yes	No	Kolmogorov-Smirnov Test	0.13535575	0.086339598	*

4.1.2.4. Relationship between Item Difficulty and Person Ability

In this section, the relationship between the estimated person ability and the estimated Thurstonian thresholds by the partial credit model was examined by the Wright map plots shown in the seven figures from Figure 16 to Figure 22. The split was based on the sections of the items, because the items in the same section usually similar estimated Thurstonian thresholds.

The seven figures were usually called Wright maps and have two parts. The upper panel was the histogram of the estimated person ability by the partial credit model. The histogram had 50 bins. For each bin, the y-axis showed the percentage of the participants who have person ability in the range of the bin. The sum of all percentages was equal to one. The same histogram was

displayed in all seven figures, because it was the same group of participants who answer different items.

The lower panel showed the estimated Thurstonian thresholds by the partial credit model for the items in the seven sections, i.e., ConL, NatL, ConT, TranT, SRLAc, SRLNeg and LoLC. A Thurstonian threshold was a location on the latent scale defined by the estimated partial credit model. The estimated person ability, item difficulty and item thresholds were all in the latent scale, such that the estimated person ability could be compared against the estimated item difficulty and the item thresholds. Based on the estimated item difficulty and the item thresholds, Thurstonian thresholds could be estimated on the same latent scale. A Thurstonian threshold could be used to separate two item points. In other words, at a Thurstonian threshold, the probability of a participant being predicted to choose a point was equal to the probability of the same participant being predicted to choose the upper point. As a result, every item had four Thurstonian thresholds, because every item had five-points. Based on the Thurstonian thresholds of an item, given a person ability value of a participant in the latent scale, the partial credit model tells which point was the most likely to be chosen by the participant for the item.

In Figure 16, Figure 18 and Figure 20, the Wright maps were shown for ConL, ConT and SRLAc consist of SRL-consistent items. Observing the three Wright maps, items in the three sections had relatively low Thurstonian thresholds, such that the partial credit model believed that the participants tended to choose the points of Agree and Strongly Agree. Especially in SRLAc, the Agree point was preferred by the majority of the participants.

In Figure 17 and Figure 19, the Wright maps were shown for NatL and TranT, which included SRL-inconsistent items. The items in these two sections had relatively high Thurstonian thresholds. Therefore, most of the participants were predicted by the partial credit model to choose the point of Disagree for the items in general. Some items had relatively evenly spread Thurstonian thresholds, like Item No. 22, indicating that the participants did not show strong a biased view on them.

In Figure 21 and Figure 22, the Wright maps were shown for SRLNeg and LoLC. These two sections were composed of SRL-inconsistent items as well, but they all had relatively evenly spread Thurstonian thresholds. In other words, the partial credit model did not believe the beliefs of the participants had any tendency of agreeing or disagreeing with SRL, as a whole.

Figure 16 *Relationship Between Person Ability and Thurstonian Thresholds for Item No. 1 To No. 13*

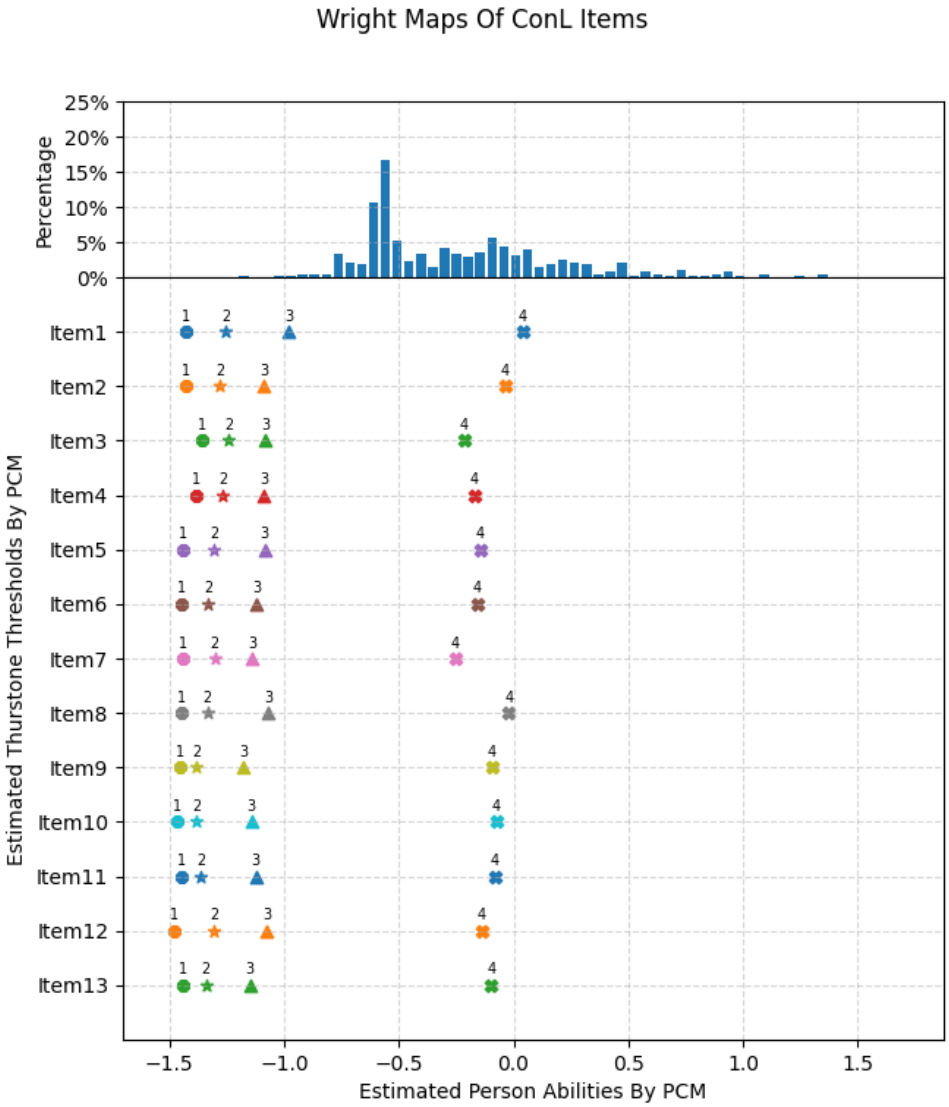


Figure 17 *Relationship Between Person Ability and Thurstonian Thresholds for Item No. 14 To No. 22*

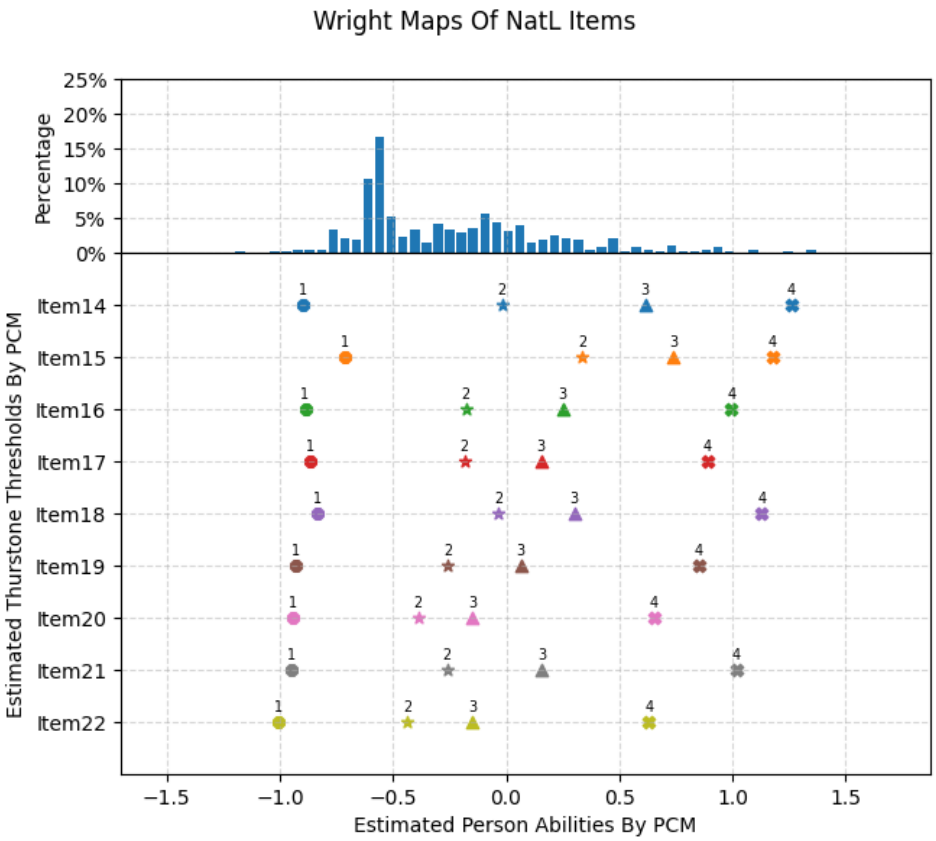


Figure 18 *Relationship Between Person Ability and Thurstonian Thresholds for Item No. 23 To No. 31*

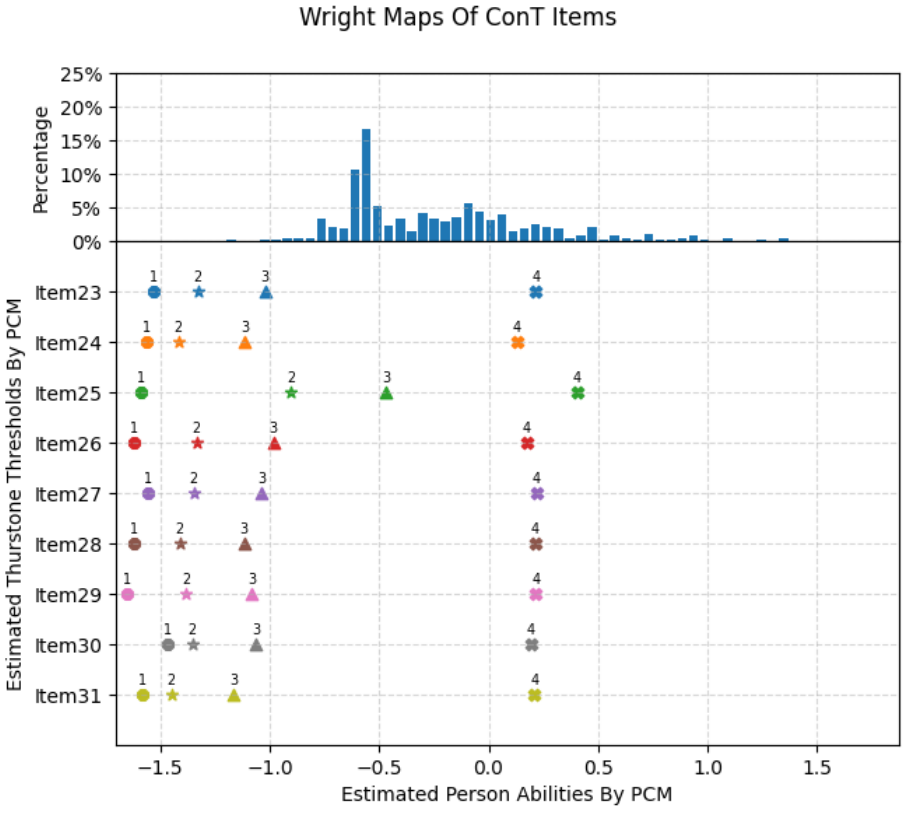


Figure 19 *Relationship Between Person Ability and Thurstonian Thresholds for Item No. 32 To No. 36*

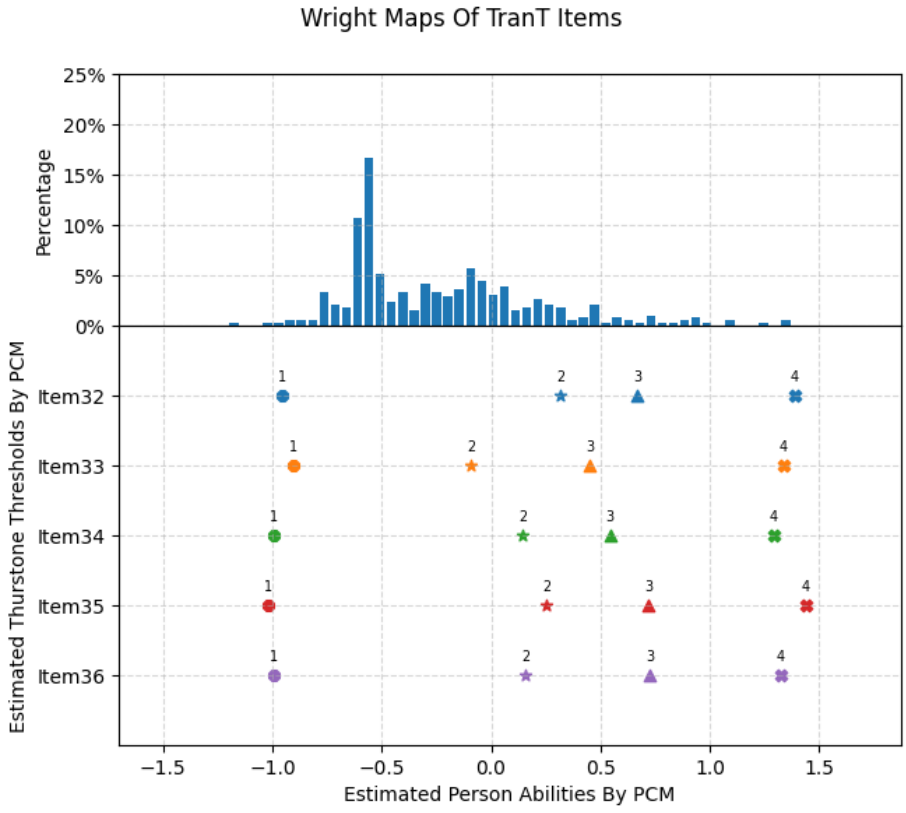


Figure 20 *Relationship Between Person Ability and Thurstonian Thresholds for Item No. 37 To No. 45*

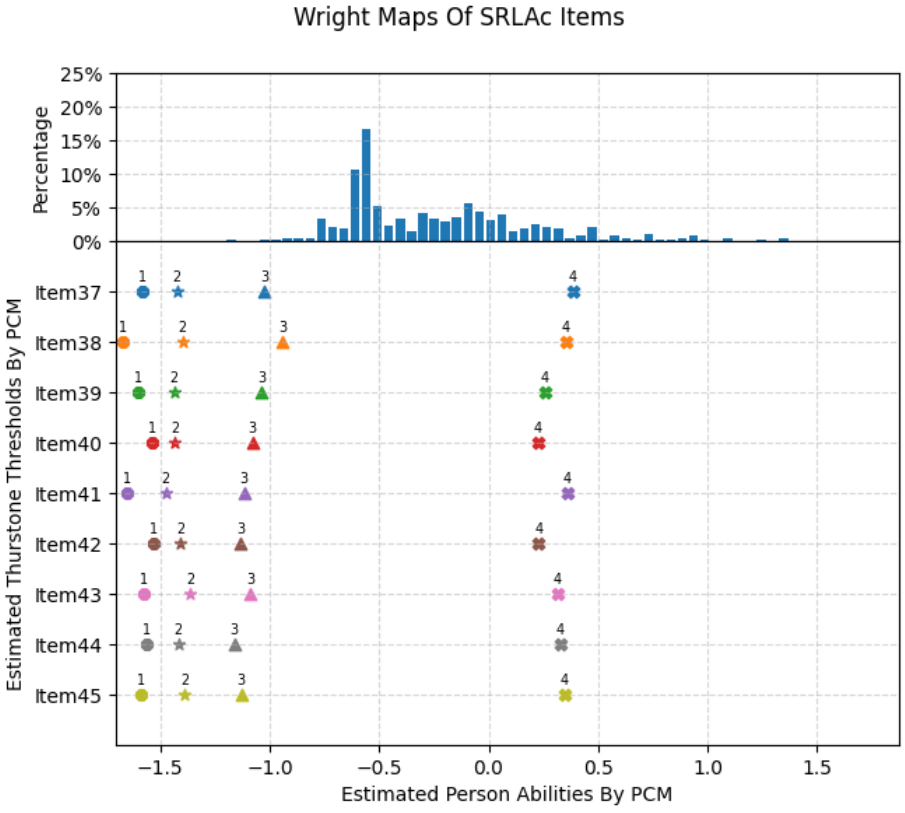


Figure 21 *Relationship Between Person Ability and Thurstonian Thresholds for Item No. 46 To No. 54*

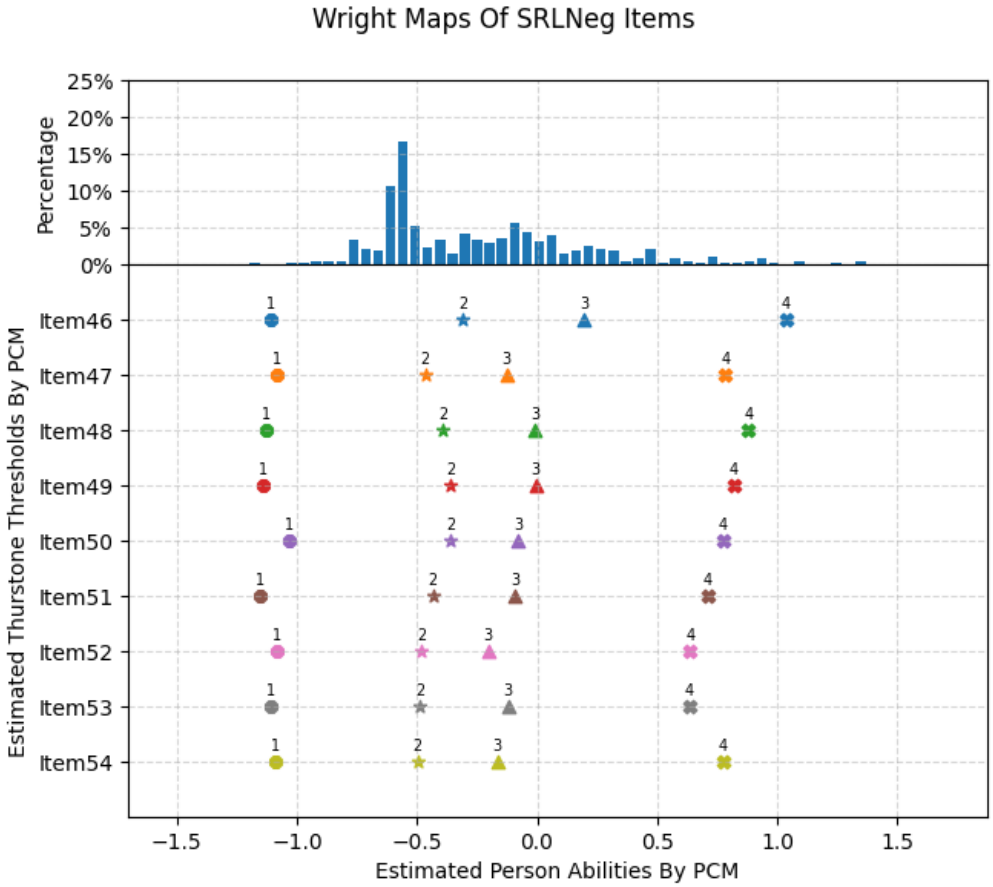
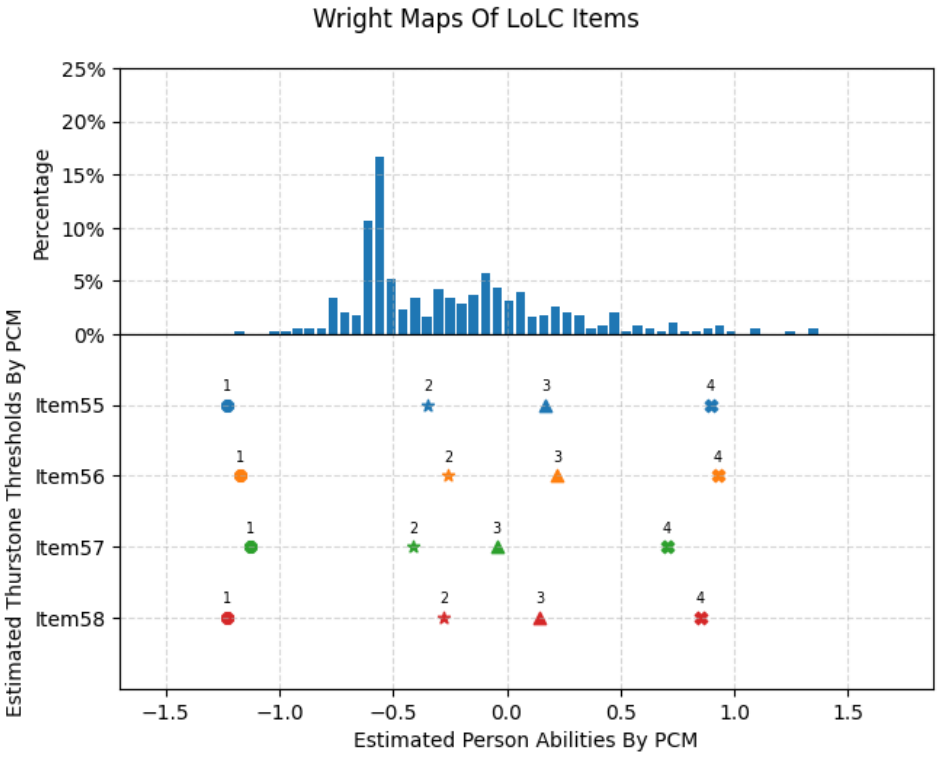


Figure 22 *Relationship Between Person Ability and Thurstonian Thresholds for Item No. 55 To No. 58*



4.1.3. Summary

Based on the item difficulty estimated by the partial credit model, there were two findings. First, most of the items had most of their points significantly separated, meaning the participants could tell the difference between most of them when answering the items. Therefore, the results of the questionnaire were valid. Second, very few items (i.e., Item No. 25 and Item No. 38) had very dispersed answers and consequently very high estimated values of the fitting statistics like

outfit and infit means of squares, which were used to measure how the observations were dispersed from the expectations from the estimated partial credit model. For example, given an item, the participants with the person abilities higher than the difficulty of the item were generally expected to choose higher points, and vice versa. But this might not hold, if the fitting statistics of the item were high.

For person ability, there were five findings. First, most of the participants have significantly non-zero person abilities, meaning the survey could effectively assess the belief consistency with SRL for them. Therefore, BALT3 was a valid questionnaire. Second, there was no significant difference between female and male participants, meaning gender was not associated with person ability. In other words, male and female pre-service teachers did not tend to have different degrees of belief consistency with SRL. Third, in general, senior students had higher belief consistency with SRL than junior students did. On average, Year 4 students showed the highest level of belief consistency with SRL, followed by Year 3, Year 1 and Year 2. Learning experience seemed to be related to students' improvement of their beliefs' consistency with SRL (Levin, 2015; Levin et al., 2013; Rahayu et al., 2020). However, the data showed that Year 1 students' belief consistency with SRL was higher than that of Year 2 students, and the belief consistency difference between Year 3 students and Year 1 students was not significant, which could be caused by the noise in the data. There might be many reasons behind the data noise. Among them, one potential reason deserves to be highlighted, i.e., the frequency and content of teaching-related courses might not be uniform and clear in different school curriculum

arrangements. Forth, teaching experience enhanced the participants' belief consistency with SRL, as shown in the data analysis. Last, pedagogical training largely enhanced the participants' beliefs consistency with SRL. The results showed that learning experience was positively associated with the pre-service teachers' beliefs regarding SRL. This also seemed to be consistent with results from other previous studies (Cleary et al., 2022; Liu et al., 2018; Vosniadou et al., 2020), and the same was true for PE in mainland China.

The relationship between the item difficulty and person ability of the survey participants was also explored. First, pre-service teachers expressed a high level of agreement in the SRL-consistent items in the sections of ConL, ConT and SRLAc. Based on the estimation result of the partial credit model, almost all of the participants possessed the beliefs that were consistent with SRL, and half of them showed very SRL-consistent beliefs in these three sections, by comparing their answers to the neutral point of the items. On the other hand, the items in the sections that were inconsistent with SRL showed relatively lower agreement on average, including NatL, TranT, SRLNeg and LoLC. The model believed the participants individually have different levels of belief consistency with SRL in these four sections. The same conclusion based on BALT3 was also found in the literature (Darmawan et al., 2020), i.e., the SRL-consistent and SRL-inconsistent beliefs might coexist in most participants. The survey participants simultaneously believed that SRL was important for students' learning under some conditions and in some scenarios but was not significant in other cases.

4.2. Qualitative Study: Results from Pre-Service Teachers Interviews

4.2.1. Summary of Interview Participant Characteristics

The interview participants were 12 males and 8 females, and there were 11 of them from Year 1 and Year 2, and the other 9 were from Year 3 and Year 4. Eighteen participants have receiving pedagogical training and 16 participants got teaching experience. From the demographic survey, only 2 interviewees had neither a pedagogical training nor an internship experience, and both were from junior grades.

There were three factors to consider when choosing interviewees. First, after doing data analysis of the BALT3 questionnaire, teachers' beliefs of SRL were distinguished into three levels, i.e., high, middle, and low consistent beliefs with SRL. This was based on the participants' abilities, which were obtained from the survey. The results showed that some students had significantly positive abilities, insignificant abilities, and significantly negative abilities. Second, it was important to separate junior and senior students because they might have different amounts of training and teaching experience. So, in terms of students' grades, they were split into two groups, i.e., the junior group (Year-1 and Year-2) and the senior group (Year-3 and Year-4). Third, gender was also an important factor.

In the quantitative analysis part, this study used the BALT3 (Darmawan et al., 2020) scale to test pre-service teachers' beliefs about learning and teaching, with the focus on SRL. The purpose of the instrument was to enable us to further examine the hypothesis that teachers might

concurrently have the beliefs that were consistent with the SRL theories and the beliefs that were directly or indirectly inconsistent with the SRL theories. The survey had 58 questions, including 30 SRL-consistent and 28 SRL-inconsistent items. Since the survey used a five-points Likert scale, it gave every participant a total score, which represented his/her overall beliefs consistency with SRL. The quantitative results showed that participants get higher scores in the items from the SRL-consistent sections but lowers scores in the SRL-inconsistent items on average.

By looking at the survey answers, the consistency and inconsistency of pre-service teachers' beliefs with SRL appeared to coexist. For example, some pre-service teachers gained high scores in the questionnaire but relatively low scores in both SRL-inconsistent sections of constructive teaching (ConT) and transmissive teaching (TranT). They agreed on the importance of strategies in learning and that a teacher's main task was to convey information, as well as the significance of SRL.

As a result, the highest belief consistency with SRL shown by a participant in an item always got the highest score. Based on the total survey scores, 385 survey participants were equally divided into three groups, i.e., high relative belief consistency with SRL, middle relative belief consistency with SRL, and low relative belief consistency with SRL. In the group of high relative belief consistency with SRL, the survey participants were contacted in the descending order of their total survey scores. In the group of low relative belief consistency with SRL, the survey participants were contacted in the ascending order of their total survey scores. In the group of middle relative belief consistency with SRL, the survey participants were randomly

contacted. The interview participants were chosen based on their availability and willingness. Finally, for the interviews, there were 7 participants chosen from the group of high relative belief consistency with SRL, 7 from the group of middle relative belief consistency with SRL, and 6 from the group of low relative belief consistency with SRL.

In addition, to ensure the privacy of the participants, the interviews were conducted anonymously, and to maintain consistency, the researchers assigned a pseudonym to each participant in alphabetical order, with a unique name for each letter of the alphabet. (Table 11)

Table 11 *Interview Participants' Demographic (n=20)*

Participant No	Gender	Grade	Pedagogical Learning	Teaching Experience	Consistency of Beliefs
Anna	Female	2	Yes	Yes	High
Bailey	Female	3	Yes	Yes	High
Catherine	Female	3	Yes	Yes	High
David	Male	1	Yes	Yes	High
Easton	Male	1	Yes	No	High
Frank	Male	3	Yes	Yes	High
Gavin	Male	4	Yes	Yes	High
Hailey	Female	2	Yes	Yes	Middle
Iris	Female	4	Yes	Yes	Middle
Joanna	Female	3	Yes	Yes	Middle
Kevin	Male	2	Yes	Yes	Middle
Lucas	Male	2	Yes	No	Middle
Michael	Male	1	Yes	Yes	Middle
Nico	Male	4	Yes	Yes	Middle
Olivia	Female	2	Yes	No	Low
Phoebe	Female	2	No	No	Low
Quincy	Male	2	Yes	Yes	Low
Ryan	Male	1	No	No	Low
Steven	Male	3	Yes	No	Low
Tyler	Male	4	Yes	Yes	Low

4.2.2. Qualitative Codes Based on Interview Transcripts

According to the research questions of this paper, five themes were identified based on the interviewees' answers. In the qualitative analysis part, five themes were employed to answer Sub-Question B and C in Research Question 1, and Research Question 2. Therefore, Theme 1 to Theme 3 were going to answer what was PE pre-service teachers' knowledge regarding SRL. Theme 4 and Theme 5 combined the quantitative data and the qualitative coding to show the relationship between beliefs and knowledge, and to analyze why interviewees presented the result as shown as before.

Theme 1. Chinese PE pre-service teachers' perceptions regarding SRL at the beginning of interviews.

Theme 2. Chinese PE pre-service teachers' knowledge regarding SRL based on Zimmerman model.

Theme 3. Grouping of interviewees by their learning methods.

Theme 4. Chinese PE pre-service teachers' beliefs regarding SRL related to their knowledge.

Theme 5. Reasons behind the observed beliefs and knowledge regarding SRL of Chinese PE pre-service teachers.

Before the interview, each participant discussed their own ideas regarding SRL. A subtheme was Perception of SRL. In addition, the second theme was focused on PE pre-service teachers' knowledge based on the revised version of the code created by Spruce and Bol (Spruce & Bol, 2015). Three subthemes were also based on Zimmerman's cyclical model: (1) Forethought Phase, (2) Performance Phase, (3) Reflection Phase. Then, the third theme categorized teachers' different knowledge about regulation learning into three subthemes: (1) Self-Regulated learning (Zimmerman Model), (2) Co-Regulated Learning, (3) Externally Regulated learning. Furthermore, the fourth theme, based on the three levels of SRL-consistency of the interviewees obtained in the quantitative analysis, summarized the different knowledge shown by PE pre-service teachers of the different levels: (1) High Level of Belief Consistency with SRL, (2) Middle Level of Belief Consistency with SRL, (3) Low Level of Belief Consistency with SRL. Last, the fifth theme was to analysis the potential reasons effect Chinese PE pre-service teachers' beliefs and knowledge: (1) Contributing Factors of Their Ideas. (2) Sources of SRL Comprehension

To easily track the different interviewees, the information about them was provided in their labels. For example, Bailey, a female from Year 3, showed high level beliefs of consistency with SRL in the survey. So, she in labelled as Bailey-Yr3-F-High.

The themes, subthemes, and codes, including supporting excerpts derived from participants interviews, were presented below in Table 12 to 17.

4.2.2.1. Themes For Answering RQ 1 (b). What is Chinese pre-service PE teachers' knowledge regarding SRL?

4.2.2.1.1. Theme 1: PE pre-services teachers' perceptions regarding SRL at the beginning of interviews.

Pre-service teachers talked and discussed extensively about their perceptions of the SRL before they were asked any leading questions. Sixteen participants have heard SRL before, so they tried to describe what they thought about it. Four participants had not known of it before, and they imagined what kind of learning it was. (Table 12)

Subtheme 1: Descriptions of Own Ideas regarding SRL

In this study, 20 pre-service teachers participated in the interview. 80% participants said they had heard of SRL or independent learning, even though the translation in Chinese was slightly different. However, most respondents had difficulty in explaining the structure or mentioned only a single component of SRL. More than half of participants described SRL as **initiative learning**, with the focus on gaining the self-control over what and when they study.

"SRL, I think there should be a separate environment with a variety of materials, so I can choose what I want to learn by myself." (Frank-Yr3-M-High)

Moreover, they emphasized learning should be self-conscious. Catherine, an interviewee from year 3, and she got high level beliefs of consistency with SRL in the survey. She mentioned,

"I usually take the initiative to learn some fields, and only say that this knowledge might be what I need to know when I am a teacher. I am interested in them, so I am motivated and do not need teachers and parents to forced me." (Catherine-Yr3-F-High).

Olivia also agreed with the idea, she said,

"I learn on my own initiative, I can control my time, and learn what I want to learn, without the pressure from teachers and parents." (Olivia-Yr2-F-Low)

Three participants described this way of learning as **student-centered learning**.

"In my cognition, SRL is mainly student-centered, and students choose their learning content and methods independently. Learners can adjust their plans to meet their own expectations. Teachers are only there to assist the students." (Bailey-Yr3-F-High)

Another other two participants interpreted SRL as **group learning**.

"In my opinion, in the context of SRL, students form a learning group with their teachers as leaders. Students can discuss with each other, umm...yes… it can be said that in the group, everyone take the initiative to participate in learning." (Tyler-Yr4-M-Low)

In contrast, six participants possessed relatively comprehensive understanding of SRL. For example, some pre-service teachers pointed out that SRL was a **learning strategy**, where learners could make plans according to their own goals, as well as monitoring the performance.

"I think it should be a subjective and active learning process with a plan and feedback, which is equivalent to knowing what to learn, how to learn, what kind of results to achieve, and whether they have learned well." (Nico-Yr4-M-Middle)

Also, adjusting learning strategies and motivating oneself were discussed.

"In my opinion, SRL should be a process to ensure learning outcomes, to improve learning outcomes, to achieve learning goals, and to actively use and regulate metacognition, motivation, and behavior. It emphasizes that learners can actively motivate themselves and have and adjust appropriate learning strategies for learning." (Michael-Yr1-M-Middle)

In summary, at this stage, no participants mentioned the content and method of reflection and learning was a circular process. They talked mostly about planning what needed to study, planning time, and making learning strategies. Therefore, when they discussed SRL based on experience, reflection and circulation were absent in learning.

Table 12 *Theme 1 PE Pre-Services Teachers' Perceptions regarding SRL at the Beginning*

Theme	Subtheme	Codes	Sub-codes/ References
PE Pre-services Teachers' Perceptions regarding SRL at the Beginning of Interviews	Description	Initiative Learning	Self-control learning content and time
			Learn what interest lies in
			Cover the shortage
		Student-Centered learning	Adjust the plan to meet own expectations
		Group Learning	Discuss with peers
		Learning Strategy	Regulated learning plan
			Set goals and get more practice

4.2.2.1.2. Theme 2: PE pre-service teachers' knowledge regarding SRL based on Zimmerman cyclical model.

The pre-service teachers talked regarding SRL-based learning strategies. The qualitative analysis was divided into three stages of SRL: (1) Forethought Phase, (2) Performance Phase,

and (3) Reflection Phase. Because some of the participants had some internship experience, they were also interviewed about their knowledge while playing the role of teacher. Each step was divided into being a participant as a student and a PE teacher (Table 13)

Subtheme 1: Forethought phase (As a student)

The forethought phase involved the beliefs and processes that took place before any attempt to learn. Within this phase, two primary categories of processes existed: task analysis and self-motivation, which mainly involved setting goals and developing strategic plans, maintaining self-efficacy beliefs regarding personal capabilities for learning (Zimmerman, 2008). Research has demonstrated that learners who set specific proximal goals for themselves often experience greater academic achievement (El-Henawy et al., 2010).

Based on interviewees' answers, forethought phase included **setting goals**, **identifying topics**, and **planning strategies**. Most interviewees indicated that they would set some learning goals, which might be phased, short-term or long-term goals. These goals were based on what information they wanted to obtain or what tasks they wanted to accomplish.

Iris gave a relatively comprehensive response.

"It is important to have a clear direction to set goals, no matter which sport subject to study. First, choose a direction, and goals what to learn in the first stage, what to learn in the second stage and in even more stages. In this way, the direction and stage are clear, and the learning goals can be completed very well, and the learning time can also be under their own control, without delay." (Iris-Yr4-F-Middle)

Iris mentioned that **learning goals** consists of staged goals, which form a long-term goal. However, when being asked about her performance in the process, she said that she felt it was often difficult to stick to plans and needed peer supervision.

Setting goals was generally related to **identifying objective**. According to the answers from the pre-service teachers, the topics could be divided into the following six categories: (1) Fill in the gaps, (2) Complete teacher tasks, (3) Meet expectations from others, (4) Self-improvement, (5) Interests, and (6) Career growth.

Gavin emphasized that they set a plan for the next day's training every night, which was a result of targeted practice before mastering the content well.

"I think, at the night before training, I think about what I've learned today and what I haven't learned yet. For example, if I want to play table tennis, I would like to practice forehand or backhand on the next day." (Gavin-Yr4-M-High)

In addition to the plans for professional training, Gavin also mentioned that he usually planned to improve his own knowledge. For example, he said:

"Apart from enhancing my weak points, I also want to improve my knowledge of sports. For example, I am interested in learning sports law and finance, because I want to gain the knowledge about physical education and the sports industry, so that I can prepare for graduation." (Gavin-Yr4-M-High)

Completing the teacher's tasks was also one of the most important items that participants took into account in identifying topics. Hailey, who recognized the importance of identifying learning topics, but more emphasized she was willing to follow her teachers, and said,

"Usually, my learning topics is to complete the task assigned by the teacher" (Hailey-Yr2-F-Middle).

Olivia also putted forward the same point of view about following teachers, saying that they didn't have many plans or goals made by themselves and basically followed the teacher's arrangement.

"Because our teachers usually assign training tasks, and then the homework is already too much for me, I do not have much time and energy to do other stuff." (Olivia-Yr2-F-Low)

Anna also proposed that teachers' tasks were more reasonable and follow the teachers' requirement was best choice for their training.

"Teachers usually have a syllabus, such as how much we are required to practice today and what milestones we need to make. The teachers' tasks are very detailed, and we follow the teacher's requirement to practice." (Anna-Yr2-M-High)

Some participants' learning topics also included their plans for future career development. In this section, 12 pre-service teachers mentioned about the acquisition of teacher certification. As we all know, the training goal of PE programs was mainly for delivering more qualified PE teachers. Teaching certification was one of the criteria for employment, and more than half of the participants said they planned to study and to take the exams.

"We can take the teaching certificate and I just want to take it before I graduate." (Steven-Yr3-M-Low)

"I want to get all the certificates in college, such as the teaching certificate and the coaching certificate." (Michael-Yr1-M-Middle)

Olivia also said that teachers and parents told her teaching certificate was important for their major and career.

"Teachers and parents asked me to get a teaching certificate, though I didn't think much of it." (Olivia-Yr2-F-Low)

Interest was the best teacher. Thus, some participants said that they enjoyed their major. learning topics were to practice their major of sports.

"Actually, I do not think too much, I just wanted to practice more (Phoebe-Yr2-F-Low)."

Easton also emphasized that he planned to learn what he was interested in.

"I really want to learn and get in touch with everything I'm interested in. For example, I took skiing as an elective this year. I want to learn it well." (Easton-Yr1-M-High)

Planning Strategies included time management and learning content planning. They were the two of important aspects that were linked to achieve goals. It was important to design a training plan according to their own characteristics and professional needs.

"To make a professional plan, I usually design the training content every day in the morning, at noon and in the evening because the mentality and state of mind are different at different time. For example, I usually feel better in the afternoon, so I practice something

new. In the morning it's more about working on strength and conditioning, and in the evening it's about reviewing." (Frank-Yr3-M-High)

Subtheme 1: Forethought phase (As a PE Teacher)

For participants with teaching experience, interviewers took advantage of their experience. Setting goals means how teachers should design classes and encourage students. Some participants said that teachers should decide what kind of goals students should accomplish and should follow the syllabus.

"I think teachers should make plans and students just finish them." (Michael-Yr1-M-Middle)

Even though Michael gave a positive attitude and relatively comprehensive explanation of SRL, he gave the opposite understanding when the role changed to teachers. This phenomenon was reflected in the responses from many pre-service teachers. Hailey also gave a similar opinion.

"I think it's a different position. I'm the teacher now, I'm the coach for those students, so I definitely have to do things like preparing course objectives and giving the students homework after class. And then we talk to the parents about the student's situations." (Hailey-Yr2-F-Middle)

Subtheme 2: Performance phase (As a student)

The performance phase referred to the processes that occurred during behavioral implementation (El-Henawy et al., 2010). The performance phase encompassed two primary categories of processes: self-control and self-observation. The former was primarily

demonstrated through techniques such as imagery, self-instruction, attention focusing, and task strategies, while the latter involved self-recording personal events and conducting self-experimentation to identify the underlying causes of these events (Zimmerman, 2008).

Coding extraction was based on the interviewee's discussion, their own strategies and methods in the performance stage in the process of practice and learning. Many participants mentioned **monitor strategies** such as using video recordings, checklists, online learning, **self-practice, self-talk, instructor guidance, and peer support**. Many interviewees used video recording as one of their important strategies to monitor their learning and practice, which was also mentioned for many times in the reflection stage. In sports training, watching their own training in videos was a common method. Gavin said,

"No matter if we are in class or in a game, the coach would let us set up a video recorder." (Gavin-Yr4-M-High)

Anna agreed and added.

"It is probably just during practice when I need to record and record my performance, which has improved my performance a lot. Sometimes, when teachers tell me what to do, I don't fully understand immediately. After classes, I watch the video and it becomes much clearer." (Anna-Yr2-M-High)

Catherine incorporated both checklists and online learning into her monitoring process.

"I make a list when I do something, and then I cross the items in the list off after I finish them. Then I can see what I have done and what I haven't. When I have a question that I

can't solve in my studies, the first thing that I usually do is to search for it in TikTok, Zhihu, and Weibo." (Catherine-Yr3-F-High)

Other participants also noted the ubiquity of online learning in this era. You can find all the materials and videos you need on the Internet, no matter whether you are studying for a teacher's certificate or sports training. Michael said,

"I usually search in TikTok, so I know how others learn." (Michael-Yr1-M-Middle).

Kevin, a ballroom dancing student, talked about his experience while practicing.

"For example, when I need to find a suitable combination of movements, I go to the Internet to search for videos, especially the videos made by foreign players, or videos from the players of high levels, from which I choose my favorite movements to learn." (Kevin-Yr2-M-Middle)

Self-talk was a word that sports students emphasize quite often. They saw it as a process of self-encouragement, mental adjustments, and reminding themselves of technical essentials. It was usually used before a game or an exam.

"I close my eyes and go through the key points. I talk with myself about what I didn't do well in my training and what I need to pay attention to now. In this process, you must calm down yourself and keep your body warm." (Iris-Yr4-F-Middle)

Quincy said that they generally recalled what their coaches told them in regular training.

"We have a lot to work with, right? To do these things well, we must always recall the key points and strategies that our coaches told us. And just remind myself if I forget in self-talk." (Quincy-Yr2-M-Low)

About **self-practice**, **teacher guidance**, and **peer support**, the participants also gave their own opinions, and some thought about how they could master time and content more flexibly by practicing. The secret was to practice according to your needs. For example, Ryan stated,

"We must practice on our own. Teachers can't supervise you all the time. After teachers finish teaching, I went to practice by myself. And I prefer to practice alone. It was hard to keep track of my progress when there are too many people practicing together." (Ryan-Yr1-M-Low)

Others emphasized the need for both **teacher guidance and self-practice**. Because teachers could point out problems more accurately.

"It's definitely something that needs to be taught at the beginning, and then it becomes a steady pattern of learning about how to practice. Then you can practice on your own. If teachers have time, they guide you and point out problems, which is also a great progress." (David-Yr1-M-High)

Some students also said that listening to the teacher was a natural habit.

"Sometimes I may make mistakes when I practice on my own, but teacher guidance is better for my progress. I usually follow whatever teachers told me to do." (Olivia-Yr2-F-Low)

Peer support was the learning method preferred by more participants, who believed that peers could supervise each other, give advice, and make training more interesting.

Michael, a track and field major student, said,

"I often practice with my friends after classes. My friends often give me encouragement." (Michael-Yr1-M-Middle)

Tyler reported more support from peers.

"My friend and I monitor each other, and we feel motivated when practicing. Sometimes when I don't practice enough, he reminds me. When he wants to give up, I also encourage him." (Tyler-Yr4-M-Low)

Hailey emphasized that peers could give more ideas.

"When I practice with a friend, we are working together, and we can monitor each other, and it is more fun. Sometimes when I think or practice, I do not observe my own problems, or my thoughts are simple. Friends give each other new ideas." (Hailey-Yr2-F-Middle)

Subtheme 2: Performance phase (As a PE Teacher)

Some participants with **teaching** experience also mentioned some **strategies** obtained when they were teachers, such as group practicing, setting rewards and setting questions. However, there were others who struggled to put into words how they supervise students. Phoebe mentioned video recording, peer exercises and other strategies when talking about their learning performance. However, when being asked about how you supervise students as a teacher. She said,

"I just copied my own teacher's lessons style." (Phoebe-Yr2-F-Low)

Frank identified group learning as one of their most common strategies.

"I would divide the students into groups because some students learn fast, and some students learn slowly. I divided them and let them work together, which I think is more efficient." (Frank-Yr3-M-High)

Giving students questions before classes and giving them rewards were also common strategies. This could effectively improve students' learning efficiency in class.

"I give them questions before they learn something new, and then let them think about it by themselves when they learn. Because if you don't give them these questions, they might not be able to learn stuff in depth. If I let them think by themselves, they have different levels of mastery of the technical essentials. Right… Setting rewards also motivates them." (Tyler-Yr4-M-Low)

Subtheme 3: Reflection phase (As a student)

The self-reflection phase encompassed the processes that occurred following each learning attempt. Within this phase, two primary categories of processes existed: self-judgment and self-reaction. Self-evaluation, self-observation, causal attribution, feelings of self-satisfaction and positive affect towards one's performance, and the manifestation of adaptive or defensive responses were among the main components of this phase (Zimmerman, 2008).

In the responses to questions about post-learning assessment, more than half of the pre-service teachers recognized the value of reflection and assessment. For sports, achieving good

competition results was a form of evaluation mentioned by many participants. Some participants value the knowledge and experience they gain in the process of learning. At the beginning of the interview, when asked about how to learn, most interviewees only mentioned planning and performance, and only a few mentioned reflections. But when the interviewer brought up the concept of reflection, almost all participants said it was important.

Based on interviewees' answers, reflection phase included **instructor feedback, peer-assessment**, **satisfaction, evaluation.** Based on their reflective experiences, more than half participants mentioned that **teachers often gave evaluation**, and they believed that evaluation by teachers or coaches was a benefit for them. For example, Michael gave his explanation that,

"Even if you got good results in the competition, teachers would still point out shortcomings that they see in the competition. Even for the champions, if there was a flaw in the movement, their coach would review it after the competition and would identify which part to improve afterwards." (Michael-Yr1-M-Middle).

Phoebe added that, besides competitions, teachers also gave evaluation in classes.

"In classes, our teachers speak out when we don't do something well. Then there's usually a summary at the end of the class and a training task for us to do on our own and a review in the next class." (Phoebe-Yr2-F-Low)

Gavin thought that coach's opinions were usually very comprehensive.

"After listening to my coach's summary and review, I basically stopped reflecting on myself, because the coach had explained it in great detail." (Gavin-Yr4-M-High)

Some participants also said that in daily study and practice, teachers were not always there. Therefore, the opinions from **peer assessment** were also important.

"I would ask my classmates in the same major and they would give me some advice and sometimes help me analyze whether my movements are right or whether the music I choose is appropriate, which I think is quite important." (Phoebe-Yr2-F-Low)

Frank mentioned practice with friends in a relaxed environment, it was easier to accept their assessment.

"When I practice with my friends, they will also say their opinions, may be not as serious as the teacher, but it is also very useful for me." (Frank-Yr3-M-High)

When talking about **satisfactions** by the interviewees, some of them focused on results, and some of them cared about what were gained in the process, and some paid more attention to whether have made progress in a period.

Pre-service teachers used many criteria to assess their learning and to determine if they were satisfied with their learning performance, such as whether the new information learned was applicable to their classrooms and whether the newly practiced moves contributed to their skill improvement. Kevin said that what all athletes wanted to be a champion.

"If I play in competitive games, I definitely want good results, because I think it's all about the championship. I definitely want to get it." (Kevin-Yr2-M-Middle)

Ryan emphasized that what was gained in games was the most important.

"Competition and learning are processes of finding out what is not good enough. And in these processes, we improve ourselves." (Ryan-Yr1-M-Low)

Frank added,

"I think there are definitely good and bad learning outcomes. The more you fail now, the stronger you will be later." (Frank-Yr3-M-High)

The participants used two strategies for **self-evaluating**, i.e., recording and watching video and writing self-summary. They gave detailed explanations about video recordings and the associated importance in the performance phase and the reflection phase. The participants reported that it was usually requested by their coaches to record videos, but they were used to it and kept the habit of recording in classes without being reminded later.

"I record videos to find out the problem because I can check my moves more carefully. I will also take the videos for teachers and classmates and ask them to give their opinions. I also find it helpful to be able to compare the videos from different periods of time so that I can see my progress and shortcomings." (Anna-Yr2-M-High)

Writing summaries was also a good reflective strategy suggested by some participants.

"I usually do quick summaries after games and after training. It's a short summary of what I do well and what I don't do well. It is not easy to forget when I write it down, and then I think about what I should do in the future." (Iris-Yr4-F-Middle)

In terms of reflective methods, participants mainly mentioned teacher feedback, peer assessment, video feedback, and writing summaries. Although participants often mentioned

about adjusting plans, it was often difficult for them to articulate how they should do it and what they should practice. This means that they had difficulties in understanding the cyclic steps of SRL.

Subtheme 3: Reflection phase (As a PE Teacher)

PE teachers' habits nurturing PE students' habits. Even participants with teaching experience, they did not pay attention to cultivating students' habit of self-reflection. Instead, they usually drove the students' reflection by pointing out problems and praising them. The student simply followed them in the process and digest what they said, rather than encouraging students to evaluate themselves totally by themselves. Frank said,

"First of all, I affirm the student's achievement. I think it is very important. Then I point out problems and correct their mistakes." (Frank-Yr3-M-High).

Most of the participants thought that kids in their teaching experiences, most of students was lack of self-conscious. Therefore, they thought teachers should did more, and parents also hoped the same.

Table 13 *Theme 2: PE Pre-Service Teachers' Knowledge regarding SRL Based on Zimmerman Cyclical Model*

Theme	Subtheme	Codes	Sub-codes/ References
PE pre-service teachers' knowledge regarding SRL Based on	Planning Phase (As Student)	Goal Setting	Stage goals
			Short-term Goals
			Long-term Goals
		Identify Objective	Fill in the gaps
			Complete teacher tasks
			Meet expectations from others

Zimmerman Cyclical Model			Self-improvement
			Interests
			Career growth
		Planning Strategies	Time management
			Plan study content and schedule
	Planning Phase (As PE Teacher)	Teaching Plan	Based on course plan
			Give students clear requirements
	Performance Phase (As Student)	Monitor Strategies	Checklist
			Video recoding
			Internet research
		Self-Talk	Remind yourself and reduce stress
		Self-Practice	Be flexible with time and content
			Sports require a lot of practice over time
		Peer-Support	Encourage and support
			Cooperative practice
			Mutual supervision
			Make suggestions for each other
		Instructor Guidance	Teacher guidance make great learning progress
			Habit is the second nature
	Performance Phase (As PE Teacher)	Teaching Strategies	Group practice
			Set rewards
			Set questions
	Reflection Phase (As Student)	Instructor Feedback and Replan	Summary after class
			Give feedback during class time
			After each competition
		Peer-Assessment	Discuss
		Satisfaction	Satisfaction with process
			Satisfaction with results
			Measure vs. standard/goal
		Self-Evaluation	self-summary
			Video feedback
			Adjust the plan
	Reflection Phase (As PE Teacher)	Teaching Evaluation	Encourage
			Identify the problem
			Given new practice direction

4.2.2.1.3. Theme 3 Grouping of interviewees by their learning methods.

In Theme 2, pre-service teachers' knowledge in each stage has been analyzed, and Theme 3 focused more on each participant's answers of regulation learning knowledge in the whole interview. Three sub-themes were identified: (1) Self-Regulated Learning (Zimmerman Model), (2) Co-Regulated Learning, (3) Externally regulated Learning (Table 14).

First, the three phases in Zimmerman's model were a coherent and circular pattern, where planning, performance, and reflection did not exist in isolation. However, through the collected interview transcripts, three combinations were discovered based on the Zimmerman model. One interviewee said that she did not reflect on herself. A learning process usually finishes when the goal of it was completed. Another interviewee talked about his own training in PE, and he thought he had no plan but just followed random ideas and thoughts. There was no subjective awareness to plan. Last but importantly, the nine interviewees believed that their learning involved planning, performance, and reflection by themselves.

Second, after analyzing the interview data, it was found that nine participants mentioned peer regulation and external regulation learning by teachers and parents. Therefore, based on the overall conversations with the interviewees, three pre-service teachers adopted peer regulated learning, and six pre-service teachers employed external regulated learning.

Participants' knowledge was less affected by their grades and gender, while their consistency levels of beliefs with SRL as shown in the questionnaire were different. In general,

participants who had higher consistent beliefs regarding SRL had more comprehensive description about their knowledge of SRL. However, in the interview, it was found that even the students who said they had learned relevant knowledge felt difficult to give a clear explanation about study process, and the concept of SRL was not mentioned in every PE college programs. In addition, in sports, the roles of peers and coaches were more important.

The results showed that PE students emphasized the importance of the practicing, no matter if they like to adopt SRL, co-regulation or external regulation.

"Practicing with teachers is the first step. We have to practice on your own as well. For example, if I want to learn a move, I learn it firstly from my teacher, or practice a skill move to learn it, though it takes me a lot more time. Another example is that, if I learn a jump, I learn it in one go. I don't think that's possible. I have to practice it many times before I get good at it. And then I gain muscle memory." (Anna-Yr2-M-High)

"I think the most important thing of sports is to practice, I must practice. If I don't practice, I cannot keep up with the teacher's progress." (Lucas-Yr2-M-Middle)

"Specializing in sports takes a lot of time of practicing, because your physical conditions would decline if you didn't practice for a period of time or a few days, and you would feel powerless." (Olivia-Yr2-F-Low)

Subtheme 1: Self-Regulated Learning (Zimmerman Model)

The knowledge in self-regulated learning of the 11 participants could be classified into three categories based on the combinations of the Zimmerman model components. They were (1) Planning+ Performance, (2) Performance+ Reflection, (3) Planning+ Performance+ Reflection.

Among them, one participant indicated that they put more emphasis on planning and performance in studying and sports training, while another believed that he usually focusses on practicing and reflecting but did not give any attention to the planning stage. The rest nine participants discussed about their own practice and understanding of planning, performance, and reflection in the interview.

Planning + Performance

There was one participant classified in this combination of knowledge points on SRL, who was a female from Year 3, and she has achieved a middle level of the belief consistency with SRL in the survey.

Briefly speaking, the interpretation of SRL from Joanna was primarily about creating a student-centered classroom. In her opinion, teacher guidance and self-study coexist in PE.

"I don't think the two are exclusive to each other. For example, if a class usually has 45 minutes, the teacher can talk about the main points for 10-15 minutes, and then the rest of the time can be left to students to practice planning." (Joanna-Yr3-F-Middle)

She emphasized planning was very important. Then, when being asked about how she usually set goals, she said it was based on learning needs, and perhaps was driven by something

in which she was recently interested or by something that she needed to improve in her sport major. In practice, the more frequently used method was video learning.

When being asked if there was a reflection phase in her learning, Joanna said that she did not think too much about this question,

"Usually after achieving a learning goal, I move on to the next one, so I don't think about what I did at all." (Joanna-Yr3-F-Middle)

When being asked whether she had taken relevant courses that taught any SRL concepts, she said that the school indeed set up related courses.

"Of course, I have learned these concepts. Independent learning and inquiry-based learning are among the learning methods advocated by the state. So, I must have learned." (Joanna-Yr3-F-Middle)

Performance + Reflection

In this part, there was one participant, i.e., Quincy. He was a male from Year 2. He got a low score on the questionnaire, indicating that his belief consistency regarding SRL was low. The result of the interview showed that he was not a student good at explaining his own opinions. The answers from him to the questions were usually simple and short. He said that he usually spent very limited time thinking about making learning plans, but he focused more on practicing.

"I play football. Even when I am in holidays, I still practice. And I just love this sport and like to practice as much as possible." On reflection, he said, "Let's say something went

wrong in a match, emmm…, then I would try to summarize where went wrong and what I didn't do well." (Quincy-Yr2-M-Low)

There was no clear explanation or description about goal setting from him, so this stage was missing from his understanding of SRL. In practice, he believed that he only needed the guidance from his coach and practice by himself at the same time.

"They are equally important. I think both are necessary. Coaching and self-understanding have the same significance." (Quincy-Yr2-M-Low)

When he talked about reflection, he said:

"For example, emmm…, but I don't know how to talk about it. For example, I summarize what I need to improve in a match, then I limit the scope of improvement to what I have been trained, so that I do not repeat similar mistakes, going forward." (Quincy-Yr2-M-Low)

In general, the importance of practicing in sports could be found in the conversations with him. On the other hand, he also emphasized the indispensable role of his coaches. His knowledge source was mainly a popular short video platform named "TikTok".

Planning + Performance + Reflection

The rest nine participants discussed about planning, performance, and reflection in their learning. They were three females and six males. Six were from senior grades and three were from junior grades. Based on their scores on the questionnaire, six had high levels of beliefs consistency with SRL, two had middle levels, and one had a low level. Detailed statistics were listed in Table 14. In the interview, there were more male participants than female participants,

and it can be seen from the table that the gender difference was not significant. But grade and SRL-consistent beliefs are positively associated. Senior and high SRL-consistent-beliefs participants performed better in the three stages of the Zimmerman model, which further revealed the importance of the three stages in their learning.

Among the nine participants, one thing they had in common was that they had clear learning outcomes from their own learning and practicing, and knew what they should have learnt, how to learn, and what level they should have achieved. They described their learning process more clearly than the other did.

Bailey was asked if she had reformulated their goals based on assessments, and she said,

"I think I don't do it on purpose. But now that you mention it, I think I do. For example, in the study of textual research, I must learn the basic knowledge of it firstly, and review the knowledge points after learning. Also, I do exercises. In this process, I evaluate myself by looking at the accuracy rate, and then adjust the learning content according to the results of each exercise." (Bailey-Yr3-F-High)

She also said that although the school had an education curriculum, but it was not clear to her what were SRL's specific strategies.

"If I had a chance, I would hope to learn more SRL knowledge. I do not study it systematically, but I seem to hear about similar concepts. In some of our assignments, we need to design a course, which needs to incorporate some methods to encourage students to

practice by themselves, but the teacher did not systematically teach SRL as a standalone theory." (Bailey-Yr3-F-High)

Catherine said that she was a person who had self-discipline and planning in her daily life and had clear plans for her study and career. She mentioned that she would go on her own initiative and plan to learn some additional knowledge about technical skills in sports.

"Through searching online, watching videos and TikTok, and participating in clubs to invite students from other schools to play a match, I got a lot of feedback in this process." (Catherine-Yr3-F-High)

She also noted the importance of the role of teachers:

"I think I prefer to have teachers in the early stages because they can tell me the concepts and what I need to learn. But when I have the basic knowledge, I would like to enter the state of independent learning. Through my own thinking, summarizing, inducting, and practicing, I think it is necessary to spend my own time to do. Therefore, both teachers and self-practicing are important. It may be better to combine them." (Catherine-Yr3-F-High)

Easton thought that students who major in sports should regulate their time and state well. Students should make everything correct in their training so they can win the game.

"My coach always tells me that he has told me about all skill points, and I simply need to practice mastering them. Those who can do sports well have to rely on their own understanding and feeling." (Easton-Yr1-M-High)

Nico and Michael both recalled that the coach had mentioned regarding SRL but could not recall much about it. They said they practiced every day no matter if it was in classes or after class. About reflection, they thought they would usually think about and summarize their daily training. But at the end of the game, their coach usually leads them to do reflection.

"The coach gives us a summary after every game, and we sometimes take the initiative to reflect on it, sometimes on purpose and sometimes unintentionally. I usually got a lot of feedback after a game." (Nico-Yr4-M-Middle)

"After a match, even if we win the first place, our coach still points out our problems, such as what moves were flawed, and tells us how to improve our training afterwards." (Michael-Yr1-M-Middle)

Ryan, who received a lower score on the questionnaire, however, agreed with all three stages of SRL in the interview. He believed that learning could not be fully completed in one go. But learning required planned practice and reflection.

"Sports really can't be done in one go. You may practice one part today and consolidate it tomorrow." (Ryan-Yr1-M-Low)

Anna was a participant who got a high score. She shared similar points with Ryan. At the same time, they all mentioned that a coach could not be around all the time, and college students should fully leverage their own time to learn better.

"Teachers can't teach you all day long. After you got the basics, you must practice and to get good at it." (Ryan-Yr1-M-Low)

When it came to reflection, they thought the teacher's advice was important. However, if teachers were not around, Gavin, Frank and Anna agreed that peers could give each other useful advice.

"You may be able to analyze a problem better when you are together with your friends, because a person usually has his or her own unique way of thinking, so other people's opinion may be unexpected but inspiring." (Gavin-Yr4-M-High)

Co-Regulated Learning

A total of three participants were more likely to study with peers during the interview. Two of them were from junior grades, and the other one was from a senior grade. There were two females and one male, and they got medium and low scores on the questionnaire.

Iris believed that she did not give herself too much pressure and needed to be urged by her peers.

"I had an initial plan, but I dropped it in the middle because I was lazy, or something else appears in the middle... I think it needs to be supervised by someone else or a couple of partners so that we can work on a plan and then do it together, which is more efficient. Maybe the quality of our group work can be better." (Iris-Yr4-F-Middle)

Kevin believed that peer advice was very important and that having a peer also strengthened motivation.

"For example, if I'm going to practice, of course I want to have a friend to do it together and to keep the motivation together... He can give me some advice, for example, a move is

not suitable for me. Even though my teacher is not around, he still asks my friend to give me some advice, which I think is quite important." (Kevin-Yr2-M-Middle)

When Phoebe explained about why she liked to study with peers, she said that,

"I like to have a partner with me because the atmosphere can be different and can make me a bit more positive. For example, I probably want to slack off at the beginning on a training day, but my friend reminds me that I cannot skip a day and I must stick to it." (Phoebe-Yr2-F-Low)

She also mentioned the feedback from teachers,

"I think teachers are professionals and they usually say right things." (Phoebe-Yr2-F-Low)

Externally Regulated Learning

There were six participants who thought external guidance was more helpful for them, comparing to self- and co-regulated learning. Five were from junior grades and one was from a senior grade. They consisted of four males and two females. Among those, only one obtained a high score on the questionnaire, while the others were middle and low.

David indicated that the learning plans were mostly arranged by teachers, and the plans usually could not catch up with changes. "Teachers control everything," he said based on his own experience.

"I went to a military-style high school where you just had to follow orders from teachers." (David-Yr1-M-High).

He had teaching experience, and based on his experience as a teacher, he also expressed the consistent view that teachers should arrange plans for students.

Lucas said that their teachers often arranged everything for them to carry out self-study in high schools by making plans and completing them in groups.

"Setting a training plan is like writing an outline for a paper. Of course, it is important." (Lucas-Yr2-M-Middle)

His answer to questions related to reflection revealed that he preferred teachers' feedback over self-reflection, and he generally did not reflect on purpose.

"When we were in high school, it was all about grades. After exams, our teachers usually talk to everyone individually." (Lucas-Yr2-M-Middle)

After entering college, he said he still liked to follow his coach.

"For example, in a game, the coach stands with us all the time, and he assesses me all the time. After the game is done, he gives us guidelines for training." (Lucas-Yr2-M-Middle)

Hailey and Steven agreed on the importance of setting goals and monitoring practice. They said they would also customize goals, such as getting a teaching certificate. And they stressed the importance of goals by saying that,

"With goals, one is motivated. Otherwise, there is no sense of learning." (Hailey-Yr2-F-Middle).

However, they did not put much focus on reflection.

"It's usually done when the teacher is in class or at the end of class." (Steven-Yr3-M-Low)

Although Olivia agreed with the importance of the three stages, she still hoped that teachers could give him more help. In her childhood, she recalled that she always followed her parents and her teachers in all three stages.

"My target is to just complete the task given by the teacher, and then practice with my teammates, because a lot of sports need to be completed by a team. After class, the teacher tells us what is good and what is not good." (Olivia-Yr2-F-Low)

Tyler putted forward an interesting point. He believed that sports should have been coached, which was different from academic courses.

"Ok, I think training in sports works like this. Taking some high-level athletes for examples, such as Liu Xiang and Su Bingtian, who are very popular, they are much better than their coaches actually. Why do they still need coaches to company them in training? It is because coaches can make good plans about what they were going to do in training. Right? So, sports always need coaches." (Tyler-Yr4-M-Low)

When he spoke about his own training, he said he preferred to have peer.

"I am lazy, but when I work with classmates or training partners, we can monitor each other and encourage each other..." (Tyler-Yr4-M-Low)

He recalled that he took some education-related courses, but could not recall what he learned exactly, and said he previously heard the word of SRL from someone close to him.

Table 14 *Theme 3: PE Pre-Service Teachers' Different Knowledge about Regulation Learning*

Theme	Subtheme	Codes	Sub-codes/ References
PE Pre-Service Teachers' Different Knowledge about Regulation Learning	Self-Regulated Learning (Zimmerman Model)	Planning+ Performance	Joanna-Yr3-F-Middle
		Performance+ Reflection	Quincy-Yr2-M-Low
		Planning+ Performance+ Reflection	Bailey-Yr3-F-High
			Catherine-Yr3-F-High
			Easton-Yr1-M-High
			Nico-Yr4-M-Middle
			Michael-Yr1-M-Middle
			Ryan-Yr1-M-Low
			Frank-Yr3-M-High
			Gavin-Yr4-M-High
			Anna-Yr2-F-High
	Co-Regulated Learning		Iris-Yr4-F-Middle
			Kevin-Yr2-M-Middle
			Phoebe-Yr2-F-Low
	Externally Regulated Learning		David-Yr1-M-High
			Lucas-Yr2-M-Middle
			Steven-Yr3-M-Low
			Olivia-Yr2-F-Low
			Tyler-Yr4-M-Low
			Hailey-Yr2-F-Middle

4.2.2.2. Theme For Answering RQ 1 (c): How is Chinese pre-service PE teachers' beliefs regarding SRL relate to their knowledge?

4.2.2.2.1. Theme 4: Chinese PE pre-service teachers' beliefs regarding SRL related to their knowledge.

In Section 4.1, the quantitative analysis results showed that the participants had beliefs consistent and inconsistent with SRL. Each participant received an overall score that represented their belief consistency with SRL. Participants who received a high total score were more likely to be identified to have beliefs consistent with SRL than those who received a low total score. Based on the total survey scores, 385 survey participants were equally divided into three groups, i.e., high relative belief consistency with SRL, middle relative belief consistency with SRL, and low relative belief consistency with SRL. In Theme 3, learners were observed in three types: self-regulated learners, co-regulated learners, and externally regulated learners. Based on the findings mentioned above, the participants' learning methods were mostly mixed, meaning that they were likely to use more than one method, even if different people may have different preferences. Therefore, Theme 4 combined the quantitative results and qualitative results to analyze the relationship between different levels of belief consistency with SRL and their preferred learning methods.

This part took the scores obtained in the survey to distinguish the participants and to explore the participants' tendency towards different learning types. In total, three subthemes were

established, (1) Beliefs of Relative High Level of Consistency with SRL in the Survey, (2) Beliefs of Relative Middle Level of Consistency with SRL in the Survey, (3) Beliefs of Relative Low Level of Consistency with SRL in the Survey.

To confirm each participant's preference for the three learning methods, two steps were applied. First, NVivo was employed to search the keywords representing self-regulated learning, co-regulated learning, and externally regulated learning to calculate the word frequency (i.e., the coverage in NVivo) respectively. Thus, the proportion of similar words mentioned by participants in the full text could be obtained. For example, SRL was a type of learning in which learners take an active role in their own learning process. The keywords regarding SRL were independent study, self-study, self- practice. Co-regulated learning involved learners' shared responsibility and mutual support, where two or more individuals learned together to achieve a common learning goal, for which the keywords were classmates, peers, friends, encouragement, and collaboration. Externally regulated learning was a type of learning where an external source controlled the learning process. This external source could be a teacher, a parent, or any other individuals who set the learning goals and decided how the learning will take place, for which the keywords were teachers, parents, coaches, requirements, etc. (de la Fuente et al., 2020). After calculating the word frequencies, the three learning methods were ranked for each interview participant and their mostly preferred methods could be obtained.

Second, the word frequency analysis in above step helped researchers quickly get the insights from a large amount of text. However, it might not be completely accurate to only rely

on it because the interviews were semi-structured. The word frequency analysis had several limitations. It was unable to extract the context and figurative meaning of the keywords searched in the text, which could lead to inaccurate conclusions if the keywords were taken out of the context and only the literal meaning was considered (Panadero et al., 2019). Additionally, the relationships between words or the structure of the text could be missed, leading to important nuances in meaning being overlooked. Lastly, factors such as stop words, stemming, and repetition could affect the accuracy of the word frequency analysis (HaCohen-Kerner et al., 2020). Therefore, the second step involved reading through each interview transcript carefully and checking if any of the above limitations existed and led to inaccurate learning method preferences. If yes, adjustments were made based on the proofreading, to ensure the learning method preferences accurately reflect the interviewees' intended meanings. (Table 15)

Table 15 *Ratio of Participants Learning Types*

Participant No	SRL Keyword Frequency (%)	Co Keyword Frequency (%)	External Keyword Frequency (%)	Preference Only By Word Frequency	Preference After Proofreading
Anna	0.57	1.07	1.17	External > Co > Self	Self > Co > External
Bailey	1.02	0.34	0.85	Self > External > Co	Self > External > Co
Catherine	1.95	0.41	1.06	Self > External > Co	Self > Co > External
David	1.22	0.42	0.77	Self > External > Co	External > Self > Co

Easton	0.51	0.32	0.60	External > Self > Co	Self > External > Co
Frank	0.68	0.70	0.87	External >Co > Self	Self > Co > External
Gavin	1.60	1.01	1.07	Self > External > Co	Self > Co > External
Hailey	0.86	1.02	1.02	External > Co > Self	External > Co > Self
Iris	0.92	1.01	0.41	Co >Self > External	Co > Self > External
Joanna	1.42	0.49	0.67	Self > External >Co	Self > External > Co
Kevin	0.51	0.93	0.89	Co > External >Self	Co > External > Self
Lucas	0.85	0.64	1.06	External > Self >Co	External > Co > Self
Michael	1.36	0.51	1.28	Self > External >Co	Self > Co > External
Nico	0.51	0.56	0.85	External > Co >Self	Self > External > Co
Olivia	0.78	0.51	1.44	External > Self > Co	External > Co > Self
Phoebe	0.40	0.79	0.59	Co >External > Self	Co > Self > External
Quincy	1.53	0.17	0.68	Self > External> Co	Self > Co > External
Ryan	0.31	0.35	0.93	External > Co >Self	Self > External > Co
Steven	0.19	0.32	1.07	External > Co >Self	External > Co > Self
Tyler	0.96	0.78	1.02	External > Self > Co	External > Co > Self

In summary, some patterns were found. The participants in Theme 4 were grouped by their survey scores. The participants with high-SRL-consistent beliefs tended to use SRL as the main learning method. The participants with the beliefs of the middle-level consistency with SRL tended to mix up the three methods (aka self-regulated learning, co-regulated learning and externally regulated learning). More than half of the participants with the beliefs of the low levels of consistency with SRL preferred external or peer regulation. In next section, these

patterns were described and analyzed together with the potential contributing factors based on the participants' interviews.

As what can be seen from Table 16, learning was not a single component, especially in PE majors. They needed to practice by themselves, to be guided by teachers, and to team up with peers. For example, the following three participants came from different levels beliefs of consistency with SRL, but they all agreed that a combination of all three learning methods were needed for pursuing better performance.

"Teachers in our school will give certain guidance.... However, in the case that we are going to participate in some amateur competitions, the basic lessons taught by the teacher may not be enough. We need to improve ourselves through his way. For example, when I practice by myself, I can't do something, but I don't know the reason, so I can ask the teacher for help, so that my professional ability will be improved very quickly." (Catherine-Yr3-F-High)

"I would probably like to practice more on my own, but definitely need a coach to give me some guidance after practice or before practice." (Ryan-Yr1-M-Low）

"Assuming that we are going to participate, we would naturally expect the coach to devise the tactics and for us to practice with our teammates to learn how to collaborate effectively. This would entail practicing the skills necessary for effective teamwork." (Nico-Yr4-M-Middle)

Through the induction and summary done in Nvivo, it was found that the participants with high-SRL-consistent beliefs shown in the questionnaire were better than those with low-SRL-consistent beliefs in many perspectives, e.g., verbal communication skills, self-evaluation skills, learning planning skills and so on. The participants with high-SRL-consistent beliefs usually could give clear explanation about the facilitating and inhibiting of SRL. They believed that how to learn should be up to themselves, so they chose to learn on their own, with teachers or in a group according to their actual needs. However, more than half of the participants with low-SRL-consistent beliefs thought they should only follow their teachers.

Table 16 *Theme 4. Knowledge Shown by PE Pre-Services Teachers with Beliefs of Different SRL-Consistency*

Theme	Subtheme	Codes	Coding and Analysis
Chinese PE Pre-Service Teachers' Beliefs regarding SRL Related to Their Knowledge	High Level Beliefs of Consistency with SRL in the Survey	Anna-Yr2-F-High	Self > Co > External
		Bailey-Yr3-F-High	Self > External > Co
		Catherine-Yr3-F-High	Self > Co > External
		David-Yr1-M-High	External > Self > Co
		Easton-Yr1-M-High	Self > External > Co
		Frank-Yr3-M-High	Self > Co > External
		Gavin-Yr4-M-High	Self > Co > External
	Middle Level Beliefs of Consistency with SRL in the Survey	Hailey-Yr2-F-Middle	External > Co > Self
		Iris-Yr4-F-Middle	Co > Self > External
		Joanna-Yr3-F-Middle	Self > External > Co
		Kevin-Yr2-M-Middle	Co > External > Self
		Lucas-Yr2-M-Middle	External > Co > Self
		Michael-Yr1-M-Middle	Self > Co > External
		Nico-Yr4-M-Middle	Self > External > Co
		Olivia-Yr2-F-Low	External > Co > Self

	Low Level Beliefs of Consistency with SRL in the Survey	Phoebe-Yr2-F-Low	Co > Self > External
		Quincy-Yr2-M-Low	Self > Co > External
		Ryan-Yr1-M-Low	Self > External > Co
		Steven-Yr3-M-Low	External > Co > Self
		Tyler-Yr4-M-Low	External > Co > Self

4.2.2.3. Theme For Answering RQ 2: Why do Chinese pre-service PE teachers present the beliefs and knowledge as shown from RQ1?

4.2.2.3.1. Theme 5: Reasons behind the observed beliefs and knowledge regarding SRL of Chinese PE pre-service teachers.

Theme 5 focused on coding the sources of knowledge and contributing factors of the Chinese PE pre-service teachers, with the aim of identifying the reasons behind their observed beliefs and knowledge related to SRL. This involved exploring the sources of their knowledge from three perspectives, namely the Internet, schools, and personal experiences, in order to analyze how and why they obtained their understanding of SRL. Furthermore, the study examined the facilitating and inhibiting of SRL in their learning and teaching as contributing factors (Table 17).

Subtheme 4: Sources of SRL comprehension

There was not a significant connection between the importance of SRL knowledge justified by the interviewees and where they acquired SRL knowledge. First, it might be because in sport majors, more emphasis was placed on the role of coaches and the importance of cooperating with

peers. Second, the interviewees' experience of learning in the past showed that they were simply obedient to teachers and parents. Third, the concept of SRL comes from the West and was not a key content to be studied in mainland China, even if the concept of SRL was mentioned in the curriculum outline of PE programs.

Most participants said that, although pedagogy was a compulsory course in **universities**, teachers did not explain SRL strategies and concepts clearly.

"We have not studied SRL strategies systematically. Our teachers seem to have mentioned similar concepts, but it is not very clear for me. After learning the educational methodology, we have to design a course by ourselves, which also incorporates some content of students' independent learning. However, teachers did not explain it systematically as a theory or strategy alone." (Bailey-Yr3-F-High)

Some participants said they had heard that teachers mentioned it but could not give detailed description. Iris stated that,

"I was not impressed, but this learning strategy should have been mentioned in school. Independent learning should be a relatively common strategy, and there are different ways for teachers and students to achieve it." (Iris-Yr4-F-Middle).

Olivia said that,

"My coach usually requires us to practice after class. I don't know if this is what you mean by SRL." (Olivia-Yr2-F-Low)

A small number of participants said they had seen the word on the **Internet**. For example, Quincy said that,

"I have heard about it on TikTok." (Quincy-Yr2-M-Low)

Some participants also described their **personal experiences**, such as high school studies, the influence of their family environment on them, and their own feelings during internship. When SRL was mentioned at the beginning of the interview, Lucas and Frank also indicated that they had learned autonomy learning for many times in their past learning experiences. Lucas said,

"When we were in high schools, teachers always cultivated our consciousness. The teacher told us some fundamental knowledge, then the students asked questions, and they encouraged us to discuss in a group." (Lucas-Yr2-M-Middle).

When being asked about whether a plan and evaluation were required, participants said that the plan was mainly based on grades, and that after tests, the teacher would talk to every one of us individually and would tell us know what to enhance in next steps.

Frank, a gymnastics student, said they had been asked by their coach to learn the movements on their own for most of the time and were provided with instruction by the coach for a couple of times in a week. He said the coach taught him the habit of active learning. (Frank-Yr3-M-High)

Teaching experience was also an important source. Some participants with internship experience mentioned that the capability of learning between different students was found to be different in teaching processes, and the exercises in class were not enough for students with poor

knowledge foundation. As a result, participants offered to give students of weak knowledge foundation additional practice requirements and to evaluate them particularly in the next class period.

"The process of giving lessons to students is a source for me to gain SRL knowledge. Just give the students some practice plans and then check on them in the next class." (Steven-Yr3-M-Low)

Subtheme: Contributing Factors: Facilitating and Inhibiting

Facilitating

The higher participant scored in the survey, the more emphasis they placed on their own status in learning. Participants in both the high and medium levels of beliefs consistency with SRL generally gave higher ratings to SRL, believing that SRL helped them learn more. The facilitation of SRL included that it could improve learning motivation and interest, it could cultivate good learning habits, it could improve learning efficiency, and it could improve the ability to summarize and reflect.

First, more than half of the participants mentioned motivation and interest in learning. They believed that using SRL could better help them make plans for their learning time and content and make their own learning more motivated. Two of the low-SRL-beliefs-consistency participants also mentioned the facilitation of active learning.

"I think planned learning makes every step of my learning clear. I can learn what I am interested in, I think planned learning makes every step of my learning clear. I can control

my learning pace. Secondly, I think independent learning brings me a lot of improvement, and I can be motivated by myself, so I can quickly to absorb what I need to know." (Catherine-Yr3-F-High)

Gavin believed that independent practicing had improved his learning effectiveness and made him more interested in learning.

"I don't know about the efficiency improved by learning independently," he said. "But I think the effect is pretty good. I can practice what I want." (Participant15-Yr4-M-High)

SRL was a good learning strategy, allowing learners to have clear understanding of their own learning, how to learn, and where gaps are.

"I feel it helps me see where I'm not doing well, and then I learn more effectively because I know what to do at every step." (Participant1-Yr3-F-High)

"I think to learn something well, the most important thing is to have ideas. You have to know what you're going to learn. Another advantage is to improve my learning capability. In other words, I can't rely on others for everything. No matter what people say, in the end, it's all about how you achieve it by yourself, so you're the center of learning." (Anna-Yr2-F-High)

It was important to develop independent learning habits. Joanna said,

"If I had mastered the SRL method earlier, my PE performance would have been better. Because PE is not something in which people could be skilled and experienced in a short

period of time, it needs years of accumulation. So, SRL methods would be even more helpful if I sticked to planned physical training from a very young age." (Joanna-Yr3-F-Middle)

Lucas stated that SRL improved his decision-making skills.

"I think it is more about cultivating personal capability because in the future, after graduating, people will have to make decisions by themselves, and no one will help them. I think it's important." (Lucas-Yr2-M-Middle)

Finally, at the beginning of the interview, a few pre-service teachers actively mentioned the reflective stage, and then, after hearing a brief introduction, some of them mentioned the summarization capability.

"I think with SRL, I might have more self-practice or self-thinking. In the past, teachers gave us skills and knowledge step by step. However, SRL requires us to think and to summarize. No matter what difficulties, we need to summarize the root causes to avoid the same problem future." (Iris-Yr4-F-Middle)

"I think no matter what I learn, I needs a result to reflect my performance in a learning process. So, I think the most important experience that SRL brings to me is to find out my deficiency and any inefficiency of time management, by looking at my results, and then to change myself accordingly and finally to learn how to manage time." (Frank-Yr3-M-High)

Inhibiting

In general, the inhibiting met by the interviewees with high-SRL-consistent beliefs were mostly created by government policies, lack of knowledge, and practical concerns. Participants

with low-SRL-consistent beliefs, however, put too much emphasis on the importance of teachers in PE.

High-SRL-consistent-beliefs pre-service teachers though that most of the inhibition of implementing SRL in PE came from the current education model and some of the characteristics of PE. Some participants pointed out that the inhibition to the implementation of SRL in sports were the lack of experience, strategies and understanding about how to use SRL strategies. Bailey was a student with internship experience. She said, "I don't know how to control the degree of independent learning in teaching. I don't have such experience." (Bailey-Yr3-F-High). At the same time, she noted that many teachers cannot adopt new strategies in a short time.

"I think it is mainly the teachers, especially those who have more teaching time, who have their own syllabus and plans, as well as their own commonly used teaching designs. They may think that innovation is unnecessary, and they have to spend more time on learning the content of the college entrance exam." (Bailey-Yr3-F-High)

Coincidentally, many participants expressed their desire to have the opportunity to systematically learn SRL strategies or teaching strategies.

"When it comes to SRL, it's hard for me to immediately connect it to the cyclic learning model you're talking about. When I was growing up, I have been being told by teachers and parents that you should practice and plan to learn by yourself. I do try to achieve this sometimes, but I don't really know much of an independent learning strategy. I feel like we haven't learned much regarding SRL, so I don't really know how to do it. It would be helpful

to know a little bit more about my own learning including myself as a teacher." (Hailey-Yr2-F-Middle)

Some other participants also mentioned that in sports, SRL was more helpful for those who already knew the technical essentials. However, normal school students majoring in PE need to study one of their major programs and also need to learn other sports in order to become a qualified PE teacher in future. It was difficult for them to practice all by themselves when they were not proficient.

"I think it is difficult to conduct independent learning in PE, because I think many skills are not well understood, which needs to be taught by teachers." (Tyler-Yr4-M-Low)

Some pre-service teachers also pointed out that poor autonomy also stops young students and themselves from using SRL methods. Olivia stated that "it is human nature to prefer playing over studying, and it may be difficult to study effectively without teacher's supervision. (Olivia-Yr2-F-Low）

David also gave the same experience.

"Sometimes, I had some plans, but I always gave up when I couldn't make them. Maybe I had poor autonomy." (David-Yr1-M-High)

It was worth noting that one participant mentioned that even the world's top athletes always need a coach.

"Ok, I think training in sports works like this. Taking some high-level athletes for examples, such as Liu Xiang and Su Bingtian, who are very popular, they are much better than their

coaches actually. Why do they still need coaches to company them in training? It is because coaches can make good plans about what they were going to do in training. Right? So, sports always need coaches." (Tyler-Yr4-M-Low)

Table 17 *Reasons Behind the Observed Beliefs and Knowledge*

Theme	Subtheme	Codes	Coding and Analysis
Reasons Behind the Observed Beliefs and Knowledge regarding SRL of Chinese PE Pre-Service Teachers	Sources	Internet	TikTok
		School	Coaches required
			Teacher has mentioned without clarifying
		Experiences	High school teachers mentioned
			Parents required
			Friends and classmate said
			Intern experience summarized
	Contributing Factors	Facilitating	Cultivate good learning habits
			Improved self-summary capability
			Increase learning motivation and interests
		Inhibiting	Do not have enough experience or strategies at present
			Do not have many opportunities to practice SRL in school
			Poor self-control capability
			Difficult to accept new strategies or concepts in a short time
			The tops athletes in the world also need coaches

4.2.3. Summary

The qualitative phase involved analyzing the China PE pre-service teachers' knowledge, and then the qualitative results were combined with the quantitative ones for in-depth conclusions. This was done to explore the relationship between belief and knowledge, and to examine the reasons behind the observations.

First, in the qualitative phase, the researchers conducted interviews to explore the Chinese PE pre-service teachers' knowledge regarding SRL. Initially, most of the participants had difficulty explaining the concepts and strategies of SRL. However, after prompting from the interviewer, the respondents elaborated on their learning processes in terms of planning, performance, and evaluation. The study also identified potential contradictions between the participants' perceptions of SRL as students and as prospective teachers. Furthermore, the analysis of the interview transcripts revealed the following five learning strategies. Within the framework of the Zimmerman cyclical SRL model, one participant emphasized planning and performance in learning, while another believed that the learning process should focused on performance and reflection. Additionally, nine participants reported using planning, performance, and reflection in their learning. Three and six participants, respectively, considered co-regulated learning and externally regulated learning to be the most effective.

Second, the researchers combined the quantitative and qualitative results to assess pre-service teachers' beliefs and knowledge regarding SRL and their relationship. The quantitative results identified the three levels of belief consistency with SRL, and the qualitative analysis examined the participants' three learning methods. To determine their preferred learning methods, the researchers used NVivo to analyze the word frequencies of the keywords that reflected self-regulated, co-regulated, and externally regulated learning in the interview transcripts. To ensure accuracy, the researchers reviewed each interview transcript carefully and took into account the limitations of the word frequency analysis that could affect the accuracy of

the conclusions. Then, the study analyzed the relationship between PE pre-service teachers' beliefs and their knowledge of SRL. The results indicated that the interview participants who scored higher in the survey had a stronger sense of self and placed greater emphasis on their own efforts and time spent on studying, while those with lower scores tended to rely more on teachers and peers for help.

Third, the study explored the reasons behind the aforementioned observations, mainly focusing on the sources of knowledge and the facilitation and inhibition of SRL. These sources of knowledge included the Internet, personal experiences, and informal education by schoolteachers. However, it was found that these sources were mostly informal, highlighting the lack of formal teaching methods for the SRL knowledge. Furthermore, some participants expressed a desire to learn more teaching strategies in schools and to apply them to their future teaching work after graduation. With regard to influencing factors, the participants' views on SRL in learning and teaching combined with sports characteristics were examined. Generally speaking, the participants with the relative high belief consistency with SRL talked more about policies and methods when discussing about facilitating and inhibiting, while the participants with the low relative belief consistency with SRL placed more emphasis on their lack of self-awareness.

Chapter 5. Discussion and Conclusions

The purpose of this study was to explore the Physical Education (PE) pre-service teachers' beliefs and knowledge about Self-Regulated Learning (SRL) in mainland China, the relationships between the beliefs and knowledge, as well as the reasons contributing to this status quo.

First, the quantitative survey used the BALT3 (Darmawan et al., 2020) scale to test pre-service teachers' beliefs about learning and teaching, with the focus on SRL. The purpose of the instrument was to enable us to further examine the hypothesis that teachers might concurrently have beliefs that were consistent with the SRL theories and beliefs that were directly or indirectly inconsistent with the SRL theories. The quantitative results showed that the participants got higher scores in the items from the SRL-consistent sections but lowers scores in the SRL-inconsistent items on average. By looking at the survey answers, the consistency and inconsistency of pre-service teachers' beliefs with SRL appeared to coexist. For example, some pre-service teachers gained high scores in the questionnaire but relatively low scores in both SRL-inconsistent sections of constructive teaching (ConT) and transmissive teaching (TranT). They agreed on the importance of strategies in learning and that a teacher's main task was to convey information, as well as the significance of SRL. Based on the total survey scores, 385 survey participants were equally divided into three groups, i.e., high relative belief consistency with SRL, middle relative belief consistency with SRL, and low relative belief consistency with

SRL. Participants who received a high total score were more likely to be identified to have beliefs consistent with SRL than those who received a low total score.

Second, interviews were conducted to investigate the knowledge of Chinese PE pre-service teachers regarding SRL. The results showed that the participants could not give a clear description of the concepts and strategies of SRL, meaning that they might have not studied them formally. Second, some learning methods of PE were the same as those in academic subjects. However, PE had its own characteristics that were different from the other subjects. The interview results found that the participant mentioned peer regulation and external regulation and their importance in their learning processes, besides SRL.

Third, the researchers combined the quantitative and qualitative results to assess pre-service teachers' beliefs and knowledge regarding SRL and their relationship. The quantitative results identified the three levels of belief consistency with SRL, and the qualitative analysis examined the participants' three learning methods. First, the results showed that the SRL beliefs and knowledge of PE pre-service teachers were highly correlated. The interview participants who scored higher in the survey had a stronger sense of self and placed greater emphasis on their efforts and time spent studying, while those with lower scores tended to rely more on teachers and peers for help. Second, 3 participants expressed positive beliefs regarding SRL in questionnaires and interviews. But they did not think the application of SRL in classrooms was generally low realized. Due to the exam-orientation education system in mainland China, it was challenging to use SRL to improve students' learning outcomes in a short period. Third, the

results showed that some participants had different beliefs and knowledge as students and teachers. This inconsistency might stem from various factors, such as the student's prior experiences and beliefs about the role of teachers in learning. It was also possible that the student did not see the same level of importance of SRL in the internship as he/she did in his/her studies. Also, teachers might not trust students could do better by themselves. In addition, PE college students might not receive formal knowledge regarding SRL strategies at the university, and they might not know how to do them.

Fourth, the study explored the reasons behind the aforementioned observations, mainly focusing on the factors that might influence teachers' beliefs and knowledge of SRL and the sources of knowledge. First, many factors might contribute, including the education system and policies, the traditional culture, and the characteristics of PE in mainland China. Some localization reforms could be considered for better adaptation and development of SRL. Second, sources of knowledge included the Internet, personal experiences, and informal education by schoolteachers. However, it was found that these sources were mostly informal, highlighting the need for formal teaching methods for SRL knowledge.

Finally, limitation, recommendation, and conclusion were included.

5.1. Research Question 1 (a) PE Pre-Service Teachers' Beliefs Regarding SRL

The purpose of this part was to explore the beliefs of pre-service PE teachers on SRL, and the BALT3 scale was used as the questionnaire, which was an effective and reliable tool for studying teacher beliefs that were consistent and inconsistent with the SRL.

5.1.1. PE Pre-Service Teachers' Beliefs of Consistency and Inconsistency with SRL

Results of the relationship between the item difficulty and person ability of the survey participants showed two findings.

First, pre-service teachers were found to have expressed a high level of agreement in the SRL-consistent items in the sections of Nature of Constructive Learning (ConL), Constructive Teaching (ConT), and SRL Achieve (SRLAc). According to the partial credit model estimation result, almost all of the participants possessed the beliefs that were consistent with SRL, and half of them showed very SRL-consistent beliefs in these three sections, by comparing their answers to the neutral point of the items. This meant that more than half of the participants agreed that teachers should teach learning strategies to the students. As the self-regulation theory was rooted in constructivism epistemology (Staver, 1986), learners were considered active agents who interpreted the information they received and created their own meaning based on what they already knew. The most important activities in the learning process were those in which students derived meaning from the information they were exposed to. From this perspective, teachers

were more effective when they taught students strategies that could help them improve their learning behavior, rather than simply passing on or presenting thematic information (Vosniadou et al., 2020).

Second, the items in the sections that were inconsistent with SRL showed relatively lower agreement on average, including Quick and Natural Learning (NatL), Transmissive Teaching (TranT), SRL Negative (SRLNeg), and Locus of Learning Control (LoLC). The model indicated that the participants had low levels of belief consistency with SRL in these four sections. This meant that the participants had lower scores in the SRL-inconsistent items on average, and they also held SRL-inconsistent beliefs (Vosniadou et al., 2020). This discrepancy could potentially impede their understanding and implementation of the self-regulated learning theory in classrooms. Kramarski and Michalsky (2009) also suggested that a complex process involving cognitive beliefs and representations was necessary to transmit from a teacher-centered to a student-centered pedagogical approach successfully. This process involved shifting from a teacher-centered learning environment to a student-centered collaborative learning environment. These changes had implications for both what was taught and how learning was assessed.

The above results on the SRL-consistent and SRL-inconsistent beliefs showed that the beliefs of pre-service teachers were not isolated and discrete units but could be described as being manifested in an integrated system (Fives & Buehl, 2009; Vosniadou et al., 2020). A similar point was made by Lombaerts et al. (2009), saying that belief systems were not necessarily cohesive, and individuals "might hold contradictory beliefs" within belief systems.

The same conclusion based on BALT3 was fond in the literature (Darmawan et al., 2020), i.e., teachers had both SRL-consistent and SRL-inconsistent beliefs. For example, as noted above, SRL theory places less emphasis on the teacher's role as a simple distributor of subject information and more emphasis on teaching students to learn strategies that helped them construct knowledge effectively (Perry et al., 2015). However, a common point held by the teachers with SRL-inconsistent beliefs was that teaching was primarily concerned with the transmission of subject knowledge, and that teachers were the transmitters of their knowledge. The survey participants were likely to agree with both statements. There were three possible reasons for this. One reason was their prior knowledge and experience (Seymen, 2012; Yuan & Lee, 2014). Pre-service teachers came from diverse backgrounds and had different educational experiences, which might have shaped their different beliefs and attitudes towards teaching and learning. Some pre-service teachers might have been exposed to constructivist and self-regulated learning approaches in their previous educational experiences, which might have influenced their SRL-consistent beliefs (Darmawan et al., 2020; Vosniadou et al., 2020). In addition, pre-service teachers might also have held SRL-inconsistent beliefs due to their prior exposure to traditional, transmissive teaching methods that emphasized the teacher as the source of knowledge and the student as a passive recipient (Ambrose et al., 2010). This might have influenced their beliefs about learning and teaching, leading to SRL-inconsistent beliefs. Furthermore, pre-service teachers might also have held different beliefs about the nature of knowledge, learning, and teaching (Kramarski & Revach, 2009), which could have led to SRL-consistent and SRL-

inconsistent beliefs. For example, some pre-service teachers might have believed that knowledge was transmitted from teachers to students, while others might have believed that knowledge was constructed by students through active engagement with learning materials.

In summary, both SRL-consistent and SRL-inconsistent beliefs of pre-service teachers deserved attention. In the literature, the existing research has been focusing on examining teacher beliefs consistent with the promotion of SRL (Dignath, 2016; Lombaerts et al., 2009; Spruce & Bol, 2015). However, inconsistent beliefs also affect teaching and learning. In addition, the results also revealed the differences in the curriculum planning of pre-employment education might exist. Although the curriculum plans of the six schools all mentioned SRL, the degree of emphasis in actual teaching might be different. What the college teachers give to the students should ideally include learning methods and strategies (Fives & Buehl, 2008; Spruce & Bol, 2015; Zhang, 2010). If the curriculum designer could better understand PE pre-service teachers' consistent and inconsistent beliefs with SRL, the pre-service teachers could be trained more effectively and efficiently (Darmawan et al., 2020; Panadero, 2017; Vosniadou et al., 2020). PE Pre-service teachers should not only get the professional content knowledge and specific skills for teaching, but the beliefs in SRL was also important.

5.1.2. Suggested Changes to BALT3 to Better Fit Chinese PE Pre-Service Teacher

The BALT questionnaire was tested and developed by the researchers from Australia. Therefore, their participants were all education students from an Australian university. In this

study, there were two items that could not be fitted by the model well. In this section, some potential reasons were discussed.

Item No. 25 was "Students will only learn new material if they have opportunities to discuss it". This study was to explore the beliefs of pre-service PE teachers. Practicing was the most basic and key link to master basic skills in sports (Kitsantas et al., 2000; Kolovelonis & Goudas, 2013; Zimmerman, 2000). When students learn a new skill, it was more important for students to imitate, to practice and to have teacher's explanation of skills. Discussing has less value, on the other hand. This might be the difference between PE and academic courses. Therefore, this explains why Item No. 25 was not fit well by the model. This study suggests removing No.25 if the survey participants have the background in PE, though more data were needed to confirm this point in future studies.

Regarding Item No. 38, i.e., "When students can learn to self-regulate their learning, their achievement improves", the results of the partial credit model showed that the survey participants' answers deviated from their estimated person ability as well. This study tries to explore why this happen from three perspectives. First of all, the survey participants were PE students from mainland China, and what was SRL might not be clear to them, and the word of "self-regulate" might not very popular in China. As a result, they did not trust that self-regulation had such immediate positive impact on the success of learning. Secondly, the participants lack the knowledge of SRL. Existing studies have shown that teachers' beliefs and understanding of SRL were also inseparable (Vosniadou, 2019). When teachers had more positive understanding

of SRL strategies and believed more in the benefits of SRL for students, they would spend more time and energy to create an SRL-friendly environment to promote the implementation of SRL strategies. However, in order to provide students with better SRL learning strategies and environments, teachers need to master relevant knowledge (Dignath, 2016). Thirdly, PE was a multi-dimensional and complex subject (Graham, 2008), and the improvement of sports performance might require the efforts spent in many aspects.

5.2. Research Question 1 (b) PE Pre-Service Teachers' Knowledge Regarding SRL

Interviews were conducted to investigate the knowledge of Chinese PE pre-service teachers regarding SRL. The interview questions were developed based on Zimmerman's SRL cyclical model (i.e., the stage of forethought, the stage of performance and the stage of self-reflection) and revised from Spruce and Bol's (2015) instrument.

First, the interview protocol was developed to elicit the participants' knowledge regarding SRL in each cyclical model stage and in each subcategory in a stage. The results showed that the participants could not give clear description of the concepts and strategies of SRL, meaning that they might have not studied them formally.

Second, some learning methods of PE were the same as those in academic subjects. However, PE had its own characteristics that were different from the other subjects. The interview results found that the participant mentioned peer regulation and external regulation and their importance in their learning processes, besides SRL. Therefore, strictly adopting a single

learning strategy might not good enough for PE students, and SRL, co-regulated learning and externally regulated learning could be applied to meet the individual needs under different conditions and in different time.

5.2.1. Lack of Knowledge Transfer Regarding SRL

Pre-service teachers could not talk and discuss about their perceptions of the SRL in a clear and accurate way before the interviewer mentioned SRL related concepts in the thereafter interview questions. All participants described what they thought, whether they knew previously and what they imagine. Afterwards, the interviewer conducted a semi-structured interview based on three phases: planning, performance, and reflection. After the comparison of each participant's own answers, it was found that they more or less used the strategies of goal setting, supervision and reflection in their learning processes, even though they could not describe the definition of SRL. This suggested that they lacked a formal introduction regarding SRL and cannot fully implement the strategies. When the participants were asked if they had learned regarding SRL strategies, 90% of them said they had probably heard about it from a coach or teacher, but not clearly. Even if cultivating students' habits of inquiry-based learning and promoting the self-learning capability and practical skills of students in the continuous improvement of teaching methods were mentioned in curriculum objectives by Ministry of Education in China (*Ministry of China of The People' s Republic of China*, 2004), the PE pre-service teachers still had not gained enough knowledge regarding SRL in reality. As Kistner et

al. (2010) have previously found, almost all of the teachers who encouraged SRL in classes pursued SRL in implicit and indirect manners. Dignath and Veenman (2021) conducted a systematic review of 17 research papers that looked at SRL teaching attempts in the classroom by different teachers with different levels of experience, and also reported that there were little direct and explicit teaching strategies adopted in most classes.

Moreover, some interview participants expressed the hope that they could learn more specific teaching strategies and apply them to their teaching work after graduation. Pre-service teachers who had received explicit SRL guidance had greater understanding of the SRL strategy (Michalsky, 2021). There were also some researchers who confirmed the positive effects of professional continuing training of teachers' SRL knowledge (Kramarski & Revach, 2009; Rahayu et al., 2020; Xu & Ko, 2019). Therefore, the fact that Chinese PE pre-service teachers did not receive direct guidance on the knowledge of SRL might be one of the factors affecting their application and practice.

5.2.2. Mix of Regulated Learning Methods of SRL, Co-Regulated Learning and Externally regulated Learning for Chinese PE Pre-Service Teachers

Through sorting out the interview transcripts, it was found that the interview participants also mentioned the roles and importance of peers and teachers in learning. They believed that peer regulation and external regulation provided them with more help, both in giving advice and supervision. Most of them thought that having peer and external regulation did not conflict with

SRL. Different times or contexts using different strategies might be a helpful way to maximize the efficiency and effectiveness of their own learning. Based on the characteristic of PE and in the context of mainland China, a mix of regulated learning methods was observed to be adopted, which include self-regulated learning, co-regulated learning, and externally regulated learning. Therefore, one contribution in this study was to propose to add co-regulation and external regulation to SRL to become a mix regulated learning so that gives a more perspective for research on Chinese PE pre-service teachers.

5.2.2.1. SRL in PE and in Mainland China

Among the three phases of SRL in PE, all interviewees emphasized the importance of self-practicing in the second phase, which might be related to the background of the interview participants. In sports, the key to mastering motor skills in practice is to repeat. By repeating, students could improve their skills and become more efficient and effective in their movements (Duncan et al., 2020). Self-planning and self-reflection were not talked about by some interview participants. The potential reason was that completing the tasks and following the guidance from teachers have become their learning habits since their childhood, which might be caused by the teaching tradition, the educational system, the sport particularity and many other cultural and social factors in mainland China. However, all participants mentioned the role of peers and teachers in the learning process. They believed peer support, teacher feedback, and parent guidance could make them more effective in learning.

5.2.2.2. Co-Regulated Learning in PE and in Mainland China

Some participants rated themselves as less self-conscious and chose to practice and to study with peers. Previous studies have also confirmed that co-regulation could help learners achieve their goals to a certain extent. Students with average self-regulation reported that there were some difficulties in monitoring their motivation and regulating processes, and a gap between intention and action, even though they knew how to regulate their learning (Klingsieck, 2013; Räisänen et al., 2016; Steel, 2007). The gap indicated that students might not be able to carry out their learning plans set up by themselves, so co-regulation would help them improve their stickiness to their plans and thus learning outcomes (Räisänen et al., 2016). Second, many PE activities needed to be carried out with a partner or in a team, and it was essential to be trained and to practice collectively with others. In PE, co-regulation could help promote positive interaction, develop teamwork and communication skills, and enhance motivation and participation in physical activity (Hagger et al., 2009). Therefore, co-regulation of learning was necessary for PE.

5.2.2.3. Externally Regulated Learning in PE and in Mainland China

Some participants also pointed out the importance of external regulation, believing that teachers' guidance was generally accurate and effective. In the existing studies, most of them emphasized self-regulation or co-regulation, and very little of them mentioned the importance of teacher regulation. Placing teachers in the central of classrooms was a very traditional teaching

method. However, PE teachers play a variety of roles, including facilitator, instructor, coach and mentor (Metzler, 2017). PE teachers not only provide a safe and supportive training environment, conduct the transfer of knowledge, but also motivate the development of students' skills. Teachers must provide instructions on the basic motor skills, which were necessary for students to participate in complex sports activities. They should also help students develop higher order thinking skills related to physical activity, such as problem solving and decision-making (Hagger et al., 2009; Reeve & Tseng, 2011).

Additionally, in the traditional Chinese education system, which emphasizes the importance of teachers, students might prefer a teacher-led approach (Esmaeili et al., 2015). In addition, some students might not be able to develop the metacognitive and self-regulation skills needed for successful SRL and might require more guidance and support from teachers (Chen, 2020). In some cases, students might also lack motivation or confidence in their ability to learn independently (Dudung Ma'ruf & Cyntia Mega, 2021). As a consequence of all these potential factors, some students might prefer to study under the guidance of teachers.

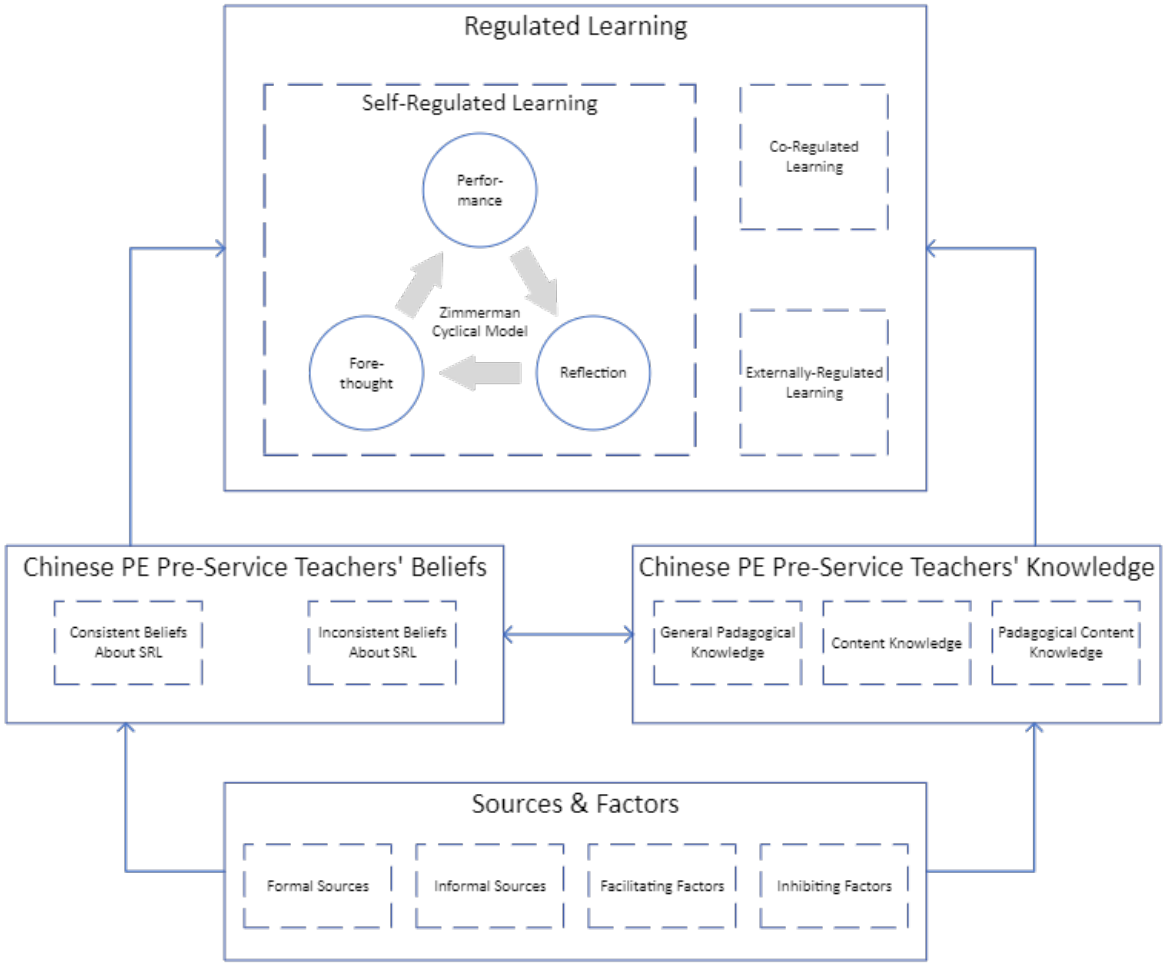
5.2.2.4. Revised Conceptual Framework Adopted for PE and Mainland China

On the top of the above analysis, applying SRL, co-regulated learning and externally regulated learning according to individual needs, abilities and conditions was a better way for helping PE students to develop a variety of learning skills (Laxdal et al., 2019; Lindblom-Ylänne et al., 2011; McBride, 2017). Previous studies and researchers gave more focus on SRL last 40

years, and emphasis its importance. However, multiple learning and teaching strategies may be adopted by students and teachers' simultaneously.

Based on the characteristic of PE and the context of mainland China, a mix of regulated learning strategies was observed to be adopted, which include SRL, co-regulated learning and externally regulated learning. Therefore, this study revised the initial conceptual framework, adding co-regulated and externally regulated learning in the box of regulated learning. SRL is still the most important strategy, and the other two also should be considered in further study.

Figure 23 *Revised Conceptual Framework*



5.3. Research Question 1 (c) How Is Chinese PE Pre-Service Teachers' Beliefs Regarding SRL Relate to Their Knowledge?

5.3.1. High Correlation of Participants' Beliefs and Knowledge Regarding SRL

The questionnaire and interview results showed that the SRL beliefs and knowledge of PE pre-service teachers were highly correlated. The interviewees who scored higher in the survey (in total 7 interview participants), most of the interviewees (i.e., 6 interview participants) in the interview showed higher self-awareness and emphasised more on their own efforts and time spent on learning. Among the interviewees who scored lower (in total 6 interview participants) in the survey, more than half interviewees (i.e., 4 interview participants) in the interview showed they were more likely to rely on the help from teachers and peers. The interviewees who obtained the scores in the middle (in total 7 interview participants) in the survey, almost half of the interviewees (i.e., 3 interview participants) preferred self-regulation, and another half of the interviewees (i.e., 4 interview participants) were likely to prefer co-regulated learning and externally regulated learning. It is a very clear pattern shown in the high consistency beliefs group. But the middle and low groups' participants knowledge is diverse so that future research can explore the pattern, which may recruit more participants.

It is necessary to differentiate between the constructs of beliefs and knowledge clearly. While beliefs are generally considered to be more effective, knowledge is considered to have higher epistemic status due to its greater justifiability when compared with beliefs (Pajares,

1992). To investigate the effects of beliefs and knowledge on teacher decision-making and problem-solving, it was important to know the connection between the two (Dignath-van Ewijk & van der Werf, 2012; Lombaerts et al., 2009; Spruce & Bol, 2015). As Dignath (2016) pointed out, there was a significant relationship between teachers' beliefs and knowledge. When teachers had more positive beliefs about schools' SRL activities and the benefits of SRL strategies for students, they spent more time and energy learning how to create an SRL-friendly environment to facilitate the deployment of SRL strategies.

However, there were two factors found in the interviews that might affect the relationship between beliefs and knowledge, such that the relationship may change under different conditions. First, three participants with high belief and knowledge held negative attitudes towards promoting SRL in sports classes in China, which showed how practical concerns and difficulties might affect the relationship. Second, according to some participants with internship experiences, when they changed their roles from students to teachers, they believed that the teacher should decide for students individually and as a whole, indicating that different roles might affect the relationship. These two factors were discussed in more details below.

5.3.2. Potentially Changing Relationship in Practice

Even though, the SRL beliefs and knowledge of PE pre-service teachers were highly correlated, there were 3 participants with positive beliefs regarding SRL in questionnaires and interviews, but they did not think the application of SRL in classrooms was generally realistic.

This might be explained by a theory developed in (Spruce & Bol, 2015), i.e., they might value SRL in theory, but did not see it as practical for learning and training. For example, Bailey (Bailey-Yr3-F-High) commented in the interview that the curriculum was set up with a unified syllabus. Driven by the exam-orientation education system in mainland China, the teacher's teaching plans and targets were mainly to help students learn examination materials and pass exams. It was challenging to use SRL to improve students learning outcomes in a short period of time.

There were three exiting research reports with similia results. First, Spruce and Bol (2015)'s study was focused on the in-service teacher, their found the disconnection between what teachers said and what they did, even though some interviewees were unaware of this bias. Second, in a study by Broadbent and Poon (2015), undergraduate students in a health science program were surveyed about their attitudes toward SRL. While students were generally positive regarding SRL and recognised their potential benefits, they also expressed concerns about their feasibility in practice, such as the difficulty in finding the time and motivation to participate in SRL. In mainland China, in a study by Tong et al. (2020), they interviewed Chinese college school students about their attitudes toward SRL. Students indicated that while they recognized the importance of SRL and their potential benefits, they also expressed concerns about their practicality in busy study schedules and the lack of support and guidance from teachers.

5.3.3. Potentially Changing Relationship in Different Roles

The interview results showed that some participants had different beliefs and knowledge as students and as teachers. For example, Michael (Michael-Yr1- M-Middle), a student with very clear plans for his studies, also said that he would do some goal setting and then accomplish it. The participant clearly understood the importance of goal setting and accomplishing tasks in his/her studies, which were the key aspects of SRL. However, when asked about internship experience, Michael emphasised that teachers should make some plans for students. The participant's response revealed the potential contradiction of the beliefs and knowledge regarding SRL in different roles. This inconsistency might stem from a variety of factors, such as the student's prior experiences and beliefs about the role of teachers in learning. It was also possible that the student did not see the same level of importance of SRL in the internship as he/she did in his/her studies. Also, teachers might not trust students could do better by themselves. Spruce (2012) reported that a participant commented in an interview that she did not believe that middle school students were capable of self-regulation and wrote in her questionnaire that the public school system was not designed to support SRL development. In addition, PE college students might not receive formal knowledge regarding SRL strategies, and they might not know how to do them.

To address this inconsistency, it might be helpful to provide the student with more knowledge and resources on how to apply the SRL principles in teaching. This could include the

guidance on setting goals, monitoring progress, and reflecting on learning outcomes in different settings.

Additionally, it might be useful to explore the participants' underlying beliefs about learning, including their perception of the role of teachers and their own responsibility in the learning process. By understanding these factors, pre-service teachers could provide more targeted support and guidance to help students develop more consistent and effective SRL practices.

5.4. Research Question 2 Why do Chinese Pre-Service PE Teachers Present the Beliefs and Knowledge as Shown from RQ1?

5.4.1. Adaptation Localization

The interview results showed that most participants did not fully understand and apply SRL in practice. Even though some participants recognized the advantages of SRL, they still rarely used it in learning and training. For example, participants mentioned that SRL can improve their ability to self-reflect and summarize, as well as increase their interest and motivation in learning. They responded positively to the advantages of SRL. However, they thought they did not have enough experience and knowledge and did not have many opportunities to apply SRL or SRL-based instruction in the current classroom, as well as sports needed teachers and peers. This might be related to many factors, including the education system and policies, the traditional

culture, and the characteristics of PE in mainland China. For better adaptation and development of SRL, some localization reforms could be considered.

The classroom culture in the West and China differed in several ways in the past. In Western cultures, individualism and self-worth were emphasized, while in the Chinese culture, deferring to teachers and treating teachers as authorities were encouraged. In the West, students were often encouraged to participate actively in class discussions and to ask questions, with more emphasis on individualism and independent thinking. There was often more of a collaborative approach in the classroom, with students encouraged to participate in decision-making and to take ownership of their own learning. In contrast, in China, students were typically expected to respect authorities, particularly their teachers, and follow the rules set by teachers.

First, in western countries, the concept of "self" has been widely studied and emphasized in the fields of education and psychology. Self-concept, self-efficacy, self-monitoring, self-regulation and other self-related concepts were considered as important factors in students' learning and development (Lee et al., 2021; Lee, 2022; Toharudin et al., 2019). In contrast, In China, teachers were often regarded as central authorities in classrooms and had a high degree of control over what happened in classrooms. Students learned in teacher-centered classrooms, and they were more accustomed to and trusted the teacher's arrangement. As some participants mentioned, teachers usually make the right decisions because of their experience and knowledge. And they totally trust what the teacher said. Some studies showed that Chinese students have some difficulties and challenges in SRL. For example, some students might prefer to rely on

teachers' guidance rather than thinking about and solving problems independently by themselves (Wang et al., 2011).

Second, the examination system in China was believed to be a factor strongly affecting students' self-regulated learning. In China, the college entrance exam was a crucial test that determined whether a student could enter a higher education institution. As a result, many students put all their efforts on preparing for the exam and neglected the importance of independent study. In addition, the education system in China also puts too much emphasize on exam grades rather than on students' personality development and independent learning abilities (Weng, 2010). This also resulted in students paying more attention to exam-taking abilities rather than SRL abilities. One participant mentioned that when he was in high school, his teacher also talked about SRL, however, it was often difficult to implement it in practice because they needed to get satisfactory test scores. Lucas (Yr2-M-Middle) said that in high school, it was all about grades. After exams, our teachers usually talk to everyone individually. There may be some SRL involved, but it was definitely be based on test scores. Such cultural and educational differences from the West might lead to the differences between the current teacher-centered way of learning in mainland China and SRL.

Third, some students might lack the ability of self-motivation and self-regulation, might be easily affected by the external environment and might lose the motivation to learn (Li et al., 2014). All these factors affect students' acceptance and application of SRL. In recent years, in the educational reform in China, more and more educators and educational researchers have

begun to pay attention to students' SRL capability. However, a survey showed that the development of SRL in mainland China did not work well, and a cultivation of students' SRL ability was at the lower level, which was mainly caused by the highly dispersed consciousness, the oversimplified and unified teaching methods, the lack of self-feedback, and the cognitive bias of students (Lin, 2019). There was the separation of knowledge and practice in the cultivation of students' SRL ability. This phenomenon was also found in this study, where participants said they did not know how to use SRL strategies and were not explicitly taught by teachers and parents. Hailey (Yr2-F-Middle) expressed her frustration in the interview, saying that when it comes to SRL, it was hard to immediately relate it to SRL cyclical model. Teachers and parents have been telling us that we should practice and plan our studies by ourselves. Sometimes we do try to do this, but my classmates and I really do not know much about independent learning strategies. It could be that we do not know enough about SRL yet, so we do not really know what to do.

Fourth, PE was a multi-dimensional subject (Graham, 2008), which involved many aspects, including skills, tactics, health and society, etc. In sports learning, the cooperation between teachers, peers and oneself was very important. Coaches and teachers were professionals who guided students through learning and practice, who could provide knowledge about skills and tactics, help students improve their skills, and provide students with support (Haerens et al., 2013). Peer interaction could increase the spirit of cooperation and the sense of community among students, which was especially important for team sports (Fernandez-Rio & Casey, 2021;

Leisterer & Jekauc, 2019). In PE, students could also improve their individual skills and team performance by working with peers, sharing skills and experiences, and encouraging and supporting each other. Therefore, the development of SRL in sports also needs to be revised in the light of these factors. As mentioned in 5.2.2., based on the characteristic of PE and in the context of mainland China, a mix of regulated learning methods was observed to be adopted, which include self-regulated learning, co-regulated learning, and externally regulated learning.

Tong et al. (2020) investigated the psychometric characteristics of the Chinese version of the Motivated Strategies for Learning Questionnaire (MSLQ). A MSLQ survey was conducted from the 611 college students in two Chinese universities. The results showed that the cross-cultural adaptation and modification were necessary in addressing the adoption of SRL from the western to the eastern cultural patterns, especially in the context of the education in China. The adjusted model showed that the adult learners in China lacked the intrinsic goal orientation, the ambiguity of peer learning and the fragmentation of learning time.

To sum up, adapting students to the cross-cultural development and carrying out the localized reform of SRL would help PE students in mainland China understand and use SRL effectively as soon as possible. Therefore, in the development of SRL in mainland China, also should consider co-regulated learning and external regulated learning in learning process. The education reform in China was moving towards putting more emphasis on SRL by students. Developing localized learning methods for sports students in mainland China could help students

get better in many perspectives, such as lifelong learning, sport skills, learning and teaching strategies, etc.

5.4.2. Informal Sources of Beliefs and Knowledge

The estimation results of the partial credit model revealed that the consistency levels of the participants' beliefs with SRL were affected by their years in colleges, but there was not a obvious link between the years and the knowledge found in the interview. This might be due to the inconsistency of the curriculum plans arranged by schools, and it also showed that even though SRL was mentioned in the syllabus required by Ministry of Education in China, they were not widely taught in practice.

During the interview, most participants said that they had not formally learned the knowledge and strategies of SRL, but only learned about it through the Internet or from their coaches briefly. This informal source might affect the participants' beliefs and knowledge. A study has shown that students' beliefs and knowledge about learning new knowledge were influenced by various informal sources as well as formal sources (Choi & Jacobs, 2011). These sources include parents, peers, media, and personal experience. For example, parents' emphasis on achievement and grades could shape students' beliefs about the importance of self-discipline and goal setting. Peers could influence the beliefs about the value of collaboration and social support. Media, including social media, could also shape the beliefs about learning and success. Fives and Buehl (2009) mentioned that teachers' beliefs and knowledge might be derived from

informal sources such as personal experience, observation or reflection, but these sources were largely less accurate than more formal sources such as education or research (Calderhead, 1996; Spruce & Bol, 2015).

The above analysis might explain why years were not significantly linked to knowledge. The lack of formal SRL knowledge learning sources was a factor affecting the beliefs and knowledge of PE pre-service teachers. Participants commented that they had limited time in classes and the teaching mainly focused on sport professional skills.

5.5. Limitation

Like the previous research studies with quantitative and qualitative analysis, it was crucial to address both external and internal validity threats to ensure the effectiveness and reliability of the results.

5.5.1. External Validity Threat

The external validity was mainly affected by how the survey and interview participants were selected to fully represent the PE pre-service teachers in mainland China. The survey and interview participants were selected such that their backgrounds of them could be as diversified as possible by considering the gender and year of the interviewees. However, caused by the time and funding limitations, the survey and interview participants were recruited from a few top universities in sports and PE. The universities were located in a few biggest cities in mainland

China, which might limit the generalizability of the study findings to other regions or educational levels.

In addition, completing the questionnaire and participating in the interview was voluntary, with incentive awards provided by the researcher. However, the response rate of respondents who were willing to participate in the interview was very low. Out of 385 questionnaires, only 47% of participants indicated they would be willing to participate in a follow-up interview. Among the responded questionnaires, the contact information was correct in only 31% of them, which showed some participants' unwillingness to spend time and effort on the survey. This created the potential that the survey and interview participants were not representative enough to include the PE pre-service teachers of totally different levels of belief consistency with SRL and knowledge on SRL.

Furthermore, the proportion of female participants in the interviews was lower compared to their male counterparts. The criteria for selecting interviewees mainly were their availability and willingness to participate in the study. As a result of the resource constraints in terms of time and funding, the number of female participants might not be sufficient enough for studies of this kind.

Lastly, it is worth noting that the study solely relied on interviews to assess teachers' knowledge. The interview protocol was designed based on Spruce and Bol's instrument and phases in the Zimmerman model and focused on SRL in PE. While interviews provide a rich source of data and allow for in-depth exploration of participants' experiences and perspectives,

they may not capture all aspects of knowledge. Future studies may consider using additional methods, such as observations or surveys, to assess teachers' knowledge regarding more comprehensively SRL.

5.5.2. Internal Validity Threat

One internal validity threat that the BALT3 scale was a self-report measure, which might be subject to biases and inaccuracies in reporting. Students might overestimate or underestimate their use of certain learning strategies, or social desirability might also affect teachers' responses to questionnaires and interview (Podsakoff et al., 2003; Wanat et al., 2020). For example, participants might express ideas and opinions that were considered appropriate and popular in the society, and they might express more positive feelings regarding SRL than they actually did.

5.6. Directions for Future Research

To confirm or disprove these findings, future studies might include pre-service teachers from more expansive geographic areas and universities to improve the external validity of the study. It might also investigate SRL differences among pre-service teachers from different universities and regions. Also, gender can be one of factors to explore the SRL beliefs of females and males. More comprehensive sampling size can also be useful for further statistical analysis of the questionnaires to assess whether they effectively assess pre-service teachers' beliefs and

knowledge regarding SRL. Future studies can also evaluate SRL using a variety of measures, such as self-report, observation, and performance achievement.

First, building on the revised conceptual framework, future research could explore ways to improve SRL in PE and conduct interventional studies to test the effectiveness of various strategies. For example, researchers could investigate how different regulated learning strategies or instructional methods impact students' SRL in PE. Furthermore, interventional studies could be conducted to test the effectiveness of various SRL interventions, such as goal setting or self-monitoring, on students' learning outcomes in PE. By exploring these avenues, future research can contribute to a better understanding of SRL in PE and provide valuable insights for teachers and educators.

In this study, co-regulated learning and externally regulated learning also be observed in the participants' learning process. Applying SRL, co-regulated learning and externally regulated learning according to individual needs, abilities, and conditions may be a better way to help PE students to develop a variety of learning skills in mainland China. To assess teachers' knowledge of SRL, co-regulated learning, and externally regulated learning, a scale and protocol could be developed in further research. The scale would be designed to measure teachers' knowledge of each type of learning, as well as their ability to differentiate between them and apply them in practice. Developing such a scale and protocol would be a valuable contribution to the field, as it would provide a standardized way of assessing teachers' knowledge of different types of

regulated learning. This could help to identify areas where additional training or support may be needed to improve teachers' effectiveness in promoting SRL in their students.

A promising area for future research would be to explore the relationship between belief and knowledge of SRL among PE pre-service teachers who possess low and middle levels of belief consistency with SRL. The survey participants who got higher scores preferred to emphasize self and studying efforts and time. It is a very clear pattern shown in the high consistency beliefs group. But the middle and low groups' participants knowledge is diverse so that future research can explore the pattern, which may recruit more participants. By examining this relationship, researchers could gain a greater understanding of the factors that influence PE pre-service teachers' beliefs and knowledge of SRL and how these factors impact their capability to promote SRL in their future students effectively.

The results showed that some participants had different beliefs and knowledge as students and teachers. Further exploration of this topic may include the impact of more in-depth learning experiences and sports characteristics on students' development of SRL beliefs and knowledge, and whether these beliefs and knowledge influence their encouragement of SRL strategies in later teaching and learning.

Also, questions remain about whether SRL strategies should be taught directly in major of PE, and to what extent students should be instructed regarding SRL. Pre-service education is about preparing future teachers, so their knowledge and beliefs are important for future education. In this study, some pre-service teachers also highlighted their concerns in learning and

teaching, such as unified teaching arrangements lead to no time to learn and teach learning strategies. Exploring these questions further qualitatively might provide insights into future interventions to encourage teachers to implement SRL in the classroom. Existing studies demonstrated that most of the observed SRL strategies were implicit rather than explicit (Kistner et al., 2010). For pre-service teachers, however, explicit teaching strategies might help them better manage student behaviour when they become in-service teachers.

Future research may also investigate the SRL development of PE pre-service teachers from the beginning of their studies through graduation and early in their teaching career. As well as comparing the SRL of PE pre-service teachers against those of in-service and other subjects' pre-service teachers to identify the unique challenges and opportunities of SRL in PE.

5.7. Implication

The results of this study are of great significance to the theory, policy, and practice of SRL. First, from a theoretical point of view, this study found that a hybrid modulated learning strategy is more suitable for the characteristics of PE and the Chinese context, that is, combining SRL, cooperative regulation and external regulation. To provide theoretical suggestions for future research, regulation learning should not only emphasize the aspect of self but also consider peer and external regulation. The concept of SRL, as emphasized in the West, may not be directly applicable to other cultural contexts, so a more culturally sensitive approach is needed to ensure its effective implementation. Data from interviews in this study indicated that PE pre-service

teachers had limited formal knowledge of SRL, even though most of them showed positive beliefs regarding SRL and in the questionnaire and used parts or all three phases of SRL strategies in learning. However, the result showed interview participants also mentioned the roles and importance of peers and teachers in learning. They believed that peer regulation and external regulation provided them with more help, both in giving advice and supervision. Most of them thought that having peer and external regulation did not conflict with SRL. In different times or contexts, using different strategies might be a helpful way to maximize the efficiency and effectiveness of their own learning. Therefore, this study shows important theoretical implications for PE pre-service teachers in mainland China.

From a policy perspective, the findings of this study suggest that schools should provide teachers with clearer teaching objectives and set teaching guidelines to promote the effective implementation of SRL principles and strategies in the classroom. The findings demonstrated that the SRL strategies and concepts were not yet widely used in the PE classroom, PE pre-service teachers had limited formal knowledge regarding SRL, and teacher education programs needed to focus more on how to encourage pre-service PE teachers to understand and implement SRL in classrooms. This suggests that there may be a disconnect between the beliefs and practices of teachers in this context. To bridge this gap, schools could establish clear teaching objectives that align with the principles of SRL and provide teachers with guidelines and resources to help them integrate SRL strategies into their teaching practices. This might include incorporating SRL into pre-service teacher training courses and providing opportunities for pre-

service teachers to observe and practice SRL in real-work classrooms. Spruce and Bol (2015) argued that in order to increase teachers' motivation to apply SRL to teaching, interventions must be carefully designed to influence teachers' personal practice of these concepts and opportunities to practice them in the classroom. Teachers need to learn how to self-regulate and be provided with the tools and support to share SRL knowledge with their students. This training needs to begin in their teacher preparation courses and then continue as a part of the continuing professional development. Previous studies have shown that the preparation training effectively improved the personal practice of SRL by teachers (Cheung, 2009; Liyanage & Bartlett, 2010; Perry et al., 2008). Therefore, both in-service and pre-service teachers all need to have the opportunity to update their understanding of SRL and to be trained in the new SRL strategies.

The practical implications of this study suggest that pre-service teachers in mainland China would benefit from more formal training in SRL principles and strategies. The findings of this study indicate that while many teachers demonstrated positive beliefs about SRL and used SRL strategies in their learning, they lacked formal knowledge and training in SRL. This suggests that there may be a need for more comprehensive teacher training programs that specifically address SRL principles and strategies. Training programs could include a combination of theoretical and practical components. Theoretical components could provide pre-service teachers with a solid understanding of the principles of SRL, including the three phases of SRL, the role of metacognition, and the importance of self-regulation in learning. Practical components could involve hands-on training in SRL strategies, such as goal setting, self-monitoring, and self-

evaluation. Additionally, training programs could incorporate peer and teacher feedback to help pre-service teachers develop their SRL skills. In questionnaires and interviews, it was found that although some participants expressed positive beliefs about SRL, they did not believe that the application of SRL in the classroom would become a universal teaching strategy. Due to the exam-orientation education system in mainland China, it was challenging to use SRL to improve students' learning outcomes in a short period. Also, the results showed that some participants had different beliefs and knowledge as students and teachers. This situation might stem from various factors, such as the student's prior experiences and beliefs about the role of teachers in learning. Thus, Teacher education programs need to recognize the importance of cultural, educational, and PE characteristics in the implementation of SRL. Since this study found that some pre-service teachers had reservations about the applicability of SRL to Chinese students, teacher education programs should explore the factors that might influence the implementation of SRL in PE classrooms in mainland China. Then, teacher education programs can better prepare pre-service teachers to adapt SRL to the needs of students and the cultural context in which they teach.

5.8. Conclusion

The findings of this study suggested that Chinese PE pre-service teachers hold both SRL-consistent and inconsistent beliefs simultaneously. The results indicated that years of study, teaching experience, and pedagogical training had positive effects on belief consistency with SRL. However, gender did not exert a significant effect on belief consistency with SRL. Overall,

these findings provide insights into the beliefs of PE pre-service teachers regarding SRL and highlight the importance of learning experience and pedagogical training in enhancing their belief consistency with SRL.

Second, this study found that Chinese PE pre-service teachers utilized a mix of SRL, co-regulated learning, and externally regulated learning in the learning. While the teachers demonstrated positive beliefs about the importance of SRL, they also recognized the importance of external regulation, such as guidance and supervision from teachers, and co-regulation, such as support and feedback from peers. Most of them believed that having peer and external regulation did not conflict with SRL. Under different conditions, using different learning strategies might be the best method to maximize the efficiency and effectiveness of their learning. Overall, these findings highlighted the importance of explicit and direct teaching strategies in helping pre-service teachers understand and implement SRL strategies effectively.

Third, the relationship between PE pre-service teachers' beliefs about and knowledge of SRL was analyzed. The results revealed that the beliefs and knowledge of PE pre-service teachers regarding SRL were highly correlated. The interview participants who scored higher in the survey had a stronger sense of self and invested greater effort and time in studying, whereas those with lower scores tended to rely more on teachers and peers for help. In addition, although some of the participants showed a high belief consistency with SRL in the survey and possessed rich SRL knowledge in the interviews, they were not positive about applying SRL in classrooms in mainland China. In addition, the study highlighted the potential contradiction between the

interviewees' beliefs regarding SRL as students and as future teachers. To address these inconsistencies, providing guidance for applying SRL principles to teaching may be helpful. This approach may enable pre-service teachers to provide more targeted support and guidance after they enter their profession, thus helping students develop more consistent and effective SRL practices. Overall, these findings provide valuable insights into pre-service teachers' beliefs and knowledge regarding SRL. The findings may provide inspiration for teacher education and training programs to prepare future teachers to better promote SRL in their classrooms.

Finally, the study found that Chinese PE pre-service teachers' choice and application of learning strategies were influenced by both formal and informal sources of knowledge, as well as practical factors. First, the development of SRL is influenced by factors such as the education system and policies, traditional culture, and the characteristics of PE in mainland China. Western culture emphasizes individualism and self-worth, whereas Chinese culture emphasizes teachers' authority and encourages students to obey teachers; this might lead to differences in the application of SRL. Furthermore, the importance of teacher guidance, peer interaction, and teamwork should be considered when developing SRL strategies for PE. Applying SRL, coregulated learning, and external regulated learning in accordance with individual needs, abilities, and characteristics can help PE students develop diverse learning skills in mainland China. Second, the study's results indicated that the consistency of the participants' beliefs with SRL was affected by factors mainly related to their learning experience, suggesting the need for continuous education and formal training in SRL. Overall, the findings highlight the importance

of considering cultural and educational differences in the development of SRL and the need for localized approaches to improve students' SRL abilities.

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Appendix A. Demographic Survey

Please leave your contact number for lucky drawn. Each of you may have opportunity to receive ¥50 supermarket gift card.

Email Address/ Phone number: _____

1. Are you a student studying in a prepare teacher program?
   a. Yes
   b. No
2. What is your gender?
   a. Female
   b. Male
3. What is your grade?
   a. First grade
   b. Second grade
   c. Third grade
   d. Fourth grade

4. Do you join any training course as prepare as a teacher?

    a. Yes

    b. No

5. Do you have any intern experiences as a PE teacher?

    a. Yes (if you say yes, please answer the question 6 and 7)

    b. No

6. What grade level do you primarily teach?

    a. Kindergarten

    b. Primary School (grades 1-6)

    c. Middle School (grades 7-9)

    d. High School (grades 10-12)

7. On average, how many students are in your class(es)?

    a. Fill in:

8. Are you willing to participate in a 40–50-minute follow-up interview via online or face to face to talk about your experiences in the as a student who join in PE programme? Every Participants will receive a ¥100 supermarket gift card.

a. Yes

b. No

Thank you for your time and submission!

Appendix B. Beliefs About Learning and Teaching 3

No	Item Name	Description	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Nature of Constructive Learning (ConL)							
1	ConL01	Students' existing knowledge about a topic influence how they understand new information being presented by the teacher					
2	ConL03	Learning requires organization of information in memory					
3	ConL04	Learning is better when students connect new information to what they already know					
4	ConL05	When students activate their existing knowledge about a topic, they learn more					
5	ConL07	Learning is more effective when students know a lot about a topic					
6	ConL08	Students learn better if they organize what they learn in memory					
7	ConL09	When information is well organized in memory, it is more likely to be remembered					
8	ConL10	The ability to recall information depends on how well it is organized in memory					
9	ConL11	Learning involves the development of a meaningful knowledge structure					
10	ConL12	Effective learning requires the ability to detect gaps in one's own understanding					
11	ConL13	Learning is better when students can evaluate their level of understanding					
12	ConL14	Students who can detect gaps in their knowledge learn more effectively					

13	ConL15	If students ask themselves how well they have understood the material, their learning improves					
Quick and Natural Learning (NatL)							
14	NatL01	Successful students learn things quickly					
15	NatL02	If students are going to be able to learn something, it will make sense to them the first time they hear it					
16	NatL05	Some people are good learners and you can't teach people how to learn					
17	NatL06	It is a waste of time to try to understand something that does not make sense to you the first time you read it					
18	NatL07	Effective learning is always quick					
19	NatL09	The ability to learn is innate					
20	NatL10	Children know all they need to know about learning when they are born					
21	NatL11	Students who are smart must have been good learners					
22	NatL14	You cannot be taught how to learn					
Constructive Teaching (ConT)							
23	ConT01	An important task for teachers is to teach students strategies for learning					
24	ConT03	Teachers should teach students ways to integrate new information with their existing knowledge					
25	ConT05	Students will only learn new material if they have opportunities to discuss it					
26	ConT06	If teachers gave opportunities to students to collaborate with their peers, they would learn more effectively					
27	ConT07	Teachers are most effective when they create an environment that encourages students' inquiry					

28	ConT08	When teachers create an environment where students can engage in learning, students learn more					
29	ConT09	One of the main tasks of teachers is to help students interpret new information using their own words					
30	ConT10	It is important for teachers to teach students ways to remember new information					
31	ConT11	It is important for teachers to teach students ways to organize new information					
Transmissive Teaching (TranT)							
32	TranT01	The most important task of teachers consists of teaching subject knowledge					
33	TranT03	If teachers would stick more to the facts and talk less about ideas, students could get more out of class					
34	TranT05	The main task of the teacher is to dispense information					
35	TranT06	Teaching mostly involves the provision of information					
36	TranT07	The main goal of teaching is to increase the amount of knowledge in the students' memory					
SRL Achieve (SRLAc)							
37	SRLAc01	When students self-regulate their learning, their achievement can improve					
38	SRLAc02	When students can learn to self-regulate their learning, their achievement improves					
39	SRLAc03	When student learn how to learn, their performance improves					
40	SRLAc04	When students have detailed strategies for how to remember key					

		ideas, they develop better understanding					
41	SRLAc05	When students learn to regulate their learning in a lesson, their understanding improves					
42	SRLAc06	Students need to have strategies for learning to enable them to develop a good understanding					
43	SRLAc07	When students learn detailed strategies for learning, they develop better understanding					
44	SRLAc08	To develop a good understanding, students need to use both their knowledge about learning and their knowledge about subject matter					
45	SRLAc09	Students need to continuously use their knowledge about learning during a lesson to develop a good understanding					
SRL Negative (SRLNeg)							
46	SRLInc01	In a lesson, students only need to use one or two different learning strategies					
47	SRLInc02	Learning strategies are only needed when students meet a difficulty during learning					
48	SRLInc03	Students do not need to be able to describe their learning strategies					
49	SRLInc04	The strategies we use for learning do not need to be part of our conscious knowledge					
50	SRLInc05	As a student, being taught learning strategies explicitly does not help my learning					
51	SRLInc06	You do not need to understand the process of learning to be a good student					
52	SRLInc07	Learning how to use learning strategies is a waste of time.					

53	SRLInc08	Using learning strategies does not result in better learning					
54	SRLInc10	You do not need learning strategies to develop good understanding					
Locus of Learning Control (LoLC)							
55	LoLC01	Most of the time I feel I have no influence over my learning					
56	LoLC02	I feel I do not have enough control over my ability to improve my grades most of the time					
57	LoLC04	Most of the time I do not believe that I can improve my learning					
58	LoLC05	Most of the time I feel that learning is difficult					

Appendix C. Beliefs About Learning and Teaching 3 Translated in Chinese

序号	项目名称	描述	*非常不同意*	*不同意*	*不确定*	*同意*	*非常同意*
Nature of Constructive Learning (ConL)							
1	ConL01	学生对某一主题的现有知识会影响他们如何理解教师所介绍的新信息					
2	ConL03	学习需要组织记忆中的信息					
3	ConL04	当学生将新信息与他们已经知道的知识联系起来时，学习效果会更好					
4	ConL05	当学生激活他们对某一主题的现有知识时，他们会学到更多东西					
5	ConL07	当学生对某一主题了解较多时，学习会更加有效					
6	ConL08	如果学生在记忆中联系起他们所学的知识，他们会学得更好					
7	ConL09	当信息在记忆中被很好地组织起来时，它就更有可能被记住					
8	ConL10	回顾信息的能力取决于信息在记忆中的组织程度					
9	ConL11	学习包含了一个有意义的知识结构的发展					
10	ConL12	有效的学习需要有能力发现自己理解上的不足					
11	ConL13	当学生能够评估自己的理解水平时，学习效果会更好					
12	ConL14	能够发现自己知识不足的学生，学习效率更高					
13	ConL15	如果学生们能够反思自己对学习材料理解程度，他们的学习就会得到进步					
Quick and Natural Learning (NatL)							
14	NatL01	成功的学生学东西很快					
15	NatL02	如果学生想要学习一些东西，首先当他们第一次听到这个知识的时候就觉得是有意义的					
16	NatL05	有些人善于学习，你无法教会人如何学习					
17	NatL06	试图理解那些第一次读起来就没有意义的东西是浪费时间的					

18	NatL07	有效的学习总是快速的					
19	NatL09	学习的能力是与生俱来的					
20	NatL10	孩子一出生就知道他们需要知道的所有关于学习的知识					
21	NatL11	聪明的学生一定是很好的学习者					
22	NatL14	你不能被教会如何学习					
Constructive Teaching (ConT)							
23	ConT01	教师的一项重要任务就是教授学生学习策略					
24	ConT03	教师应该教学生如何将新的信息与他们现有的知识相结合					
25	ConT05	学生只有在有机会讨论的情况下才会学习新知识					
26	ConT06	如果老师给学生提供与同学合作的机会，他们会学得更有效					
27	ConT07	当教师创造一个鼓励学生探究的环境时，他们是最有效的					
28	ConT08	当教师创造一个学生可以参与学习的环境时，学生学得更多					
29	ConT09	教师的主要任务之一就是帮助学生用自己的语言解释新的信息					
30	ConT10	对老师来说，教给学生记住新信息的方法是很重要的					
31	ConT11	教师教学生组织新信息的方法是很重要的					
Transmissive Teaching (TranT)							
32	TranT01	教师最重要的任务是教授学科知识					
33	TranT03	如果老师能多讲事实，少谈想法，学生们就能从课堂上得到更多					
34	TranT05	教师的主要任务是传播信息					
35	TranT06	教学主要涉及信息的提供					
36	TranT07	教学的主要目标是增加学生记忆中的知识量					
SRL Achieve (SRLAc)							
37	SRLAc01	当学生自我调节他们的学习，他们的成绩可以提高					
38	SRLAc02	当学生能够学会自我调节学习时，他们的成绩就会提高					
39	SRLAc03	当学生学会如何学习时，他们的成绩就会提高					

40	SRLAc04	当学生们对如何记住关键思想有了详细的策略时，他们就能更好地理解					
41	SRLAc05	当学生学会在课堂上调节自己的学习时，他们的理解力就会提高					
42	SRLAc06	学生需要有学习策略，使他们能够形成良好的理解					
43	SRLAc07	当学生学习详细的学习策略时，他们能更好地理解					
44	SRLAc08	为了培养良好的理解能力，学生需要使用他们关于学习的知识和关于学科的知识					
45	SRLAc09	学生需要在课堂上不断使用他们关于学习的知识，以形成良好的理解					
SRL Negative (SRLNeg)							
46	SRLInc01	在一节课上，学生只需要使用一到两种不同的学习策略					
47	SRLInc02	只有当学生在学习过程中遇到困难时，才需要学习策略					
48	SRLInc03	学生不需要能够描述他们的学习策略					
49	SRLInc04	我们用来学习的策略不需要成为我们有意识的知识的一部分					
50	SRLInc05	作为一个学生，被明确地教导学习策略对我的学习没有帮助					
51	SRLInc06	你不需要了解学习的过程，也可以成为一个好学生					
52	SRLInc07	学习如何使用学习策略是浪费时间					
53	SRLInc08	使用学习策略并不会带来更好的学习效果					
54	SRLInc10	你不需要学习策略来培养良好的理解力					
Locus of Learning Control (LoLC)							
55	LoLC01	大多数时候，我感觉我无法影响自己的学习					
56	LoLC02	我觉得我对自己的能力没有足够的控制力，在大多数时候都无法提高自己的成绩					
57	LoLC04	大多数时候，我不相信我可以提高我的学习成绩					
58	LoLC05	大多数时候，我觉得学习是困难的					

Appendix D. Interview Protocol

Really appreciate for your help and for being a volunteer of an interview for this research. In this interview, my investigation is mainly about your beliefs and knowledge regarding SRL, which you may have already known from the questionnaire that you have done previously. Please keep in mind that this is not for assessing you but for answering the research questions proposed in the project.

To thank you for your time and efforts, you will be awarded a supermarket gift coupon of 100 RMB after completing the interview.

All of the information that I collect from our communication will be treated as a secret and will be safely discarded when the project is completed. Before discarded, any electronic data will be persisted in files protected by strong passwords and handwritten notes/papers will be kept in a locked cabinet.

Besides that, you can make a pseudonym for yourself such that the interview data can be correctly labeled and tracked. Do you have one in your mind? Or do you prefer that I choose one for you?

You may decline continuing with interview at any time.

In the future, if questions arise, please do not hesitate to contact me by writing to

or by calling

Also, please have an informed consent form. Please read it through and leave a signature on it if all terms look good to you.

Lastly, any questions or any concerns before we kick off? Do you feel comfortable that I start audio-recording our session now?

Before we ask any questions, let me describe the features of self-regulated learning. A self-regulated learner can

- determine what he wants to learn,
- find out what he needs for it,
- develop a plan to tackle a learning task,
- determine the working tempo,
- decide how to learn,
- regularly control progress, and
- make adjustments until the desired results are attained.

The antithesis of self-regulated learning is teacher-directed learning. Self-regulated learning and teacher-directed learning are not mutually exclusive, but usually exist at the same time. In practice, if an individual has most (not necessarily all) of the aforementioned activities in his learning process, we say he is a self-regulated learner.

Then let's start with our questions.

SRL Knowledge

1. What is your view on self-regulated learning? Did you know this concept before? If no, can you imagine what it sounds like? Do you see any connection between self-regulated learning and PE?

2. Do you have an experience in which you learnt something all by yourself and achieved good results? Did you guide and direct yourself or under the supervision of someone else? Did you try to evaluate your learning performance all by yourself? What do you feel about this experience?

3. How would you describe the features of a PE classroom that foster the form of self-regulated learning? Which one of them is the most important? Which one of them is the most difficult to implement?

4. Which student skill can self-regulated learning particularly improve (like performance achievement, planning capability, learning initiative, etc.)? Why?

5. Do you think learning strategies are important? Is self-regulated learning a good strategy? How could self-regulated learning improve the learning efficiency in PE?

6. Do you see any difference between self-regulated learning in PE and the teacher-directed PE instruction? Are they significant or minor? Which one do you prefer? And why?

7. Do you think there are any obstacles in implementing self-regulated learning teaching

strategies in primary and secondary schools (for example, school curriculums, teachers' beliefs and knowledge, parents, or students themselves)?

8. What problems may be encountered when using self-regulated learning to adapt to the current form of teaching? And how can it be better adapted?

9. Do you think self-regulated learning is important in PE? Is it necessary to follow it in primary and secondary schools? Why?

10. Did you learn any knowledge about self-regulated learning in your PE major program?

Planning

11. Do you think if it is necessary to make a study plan?

12. Do you have a clear plan for your college life?

13. What is your biggest motivation for learning?

    A. Learn more useful knowledge, enhance study ability

    B. Expectations and encouragement from others (friends, family, teachers, etc.)

    C. Get higher grades, scholarships, and certificates

    D. Find a good job after graduation

    E. Others

14. Do you generally have a clear plan and arrangement for your study life?

15. In your daily learning, do you often communicate with your teachers and classmates?

Monitoring

16. What do you do when you have a problem that you don't understand or can't solve?

    A. Internet

    B. Ask the teacher for help

    C. Consult books

    D. To give up

17. Usually, how would you monitor or control your own learning?

18. What kind of learning method do you think is effective in the learning process?

19. Have you ever used self-talk in your physical exercise experience? What do you think about this method?

Evaluation

20. How might you evaluate your learning after completing a learning task?

    A. Self-evaluation

B. Causal attribution

21. What are some activities that you might design to encourage self-reflection and self-evaluation after a learning task?

22. How do you determine your satisfaction with a learning outcome after you complete a learning task?

23. Would you set further goals after evaluating your current study?