CHAPTER I
INTRODUCTION

1.1 Research Background

Metacognitive or connected to metacognition knowledge is knowledge about thinking (Harrison & Vallin, 2018). Meta-cognitive has an important role in learning, namely to enhance students' memory (Finley et al., 2010; Murphy & Castel, 2020; Rivers, 2021). When preparing for a test, students frequently feel overburdened; overcome these difficulties by focusing on knowledge that will be remembered the most (Murphy & Castel, 2020). When decisions are made in situations that are representative of those faced during a criteria test, students can accurately monitor their learning while taking practice tests (Rivers, 2021). How students apply these techniques in straightforward laboratory tasks hints at how such metacognitive skills can be developed through training or experience. Information technology can be a factor in how metacognition affects memory and learning (Finley et al., 2010). Furthermore, meta-cognitive affects students' learning experiences with technology. Learning about metacognition dramatically enhances self-monitoring, note-taking, and comprehension during learning (Brady & Forest, 2018). In addition, critical thinking skills and metacognitive skills had a strong link (Amin et al., 2020; Çakici, 2018; Mohseni et al., 2020).

The meta-affective tendencies associated with feelings that students experience when preparing for class (Uzuntiryaki-Kondakci & Kirbulut, 2016). Emotion control can change the feelings. The influence on success and failure in crucial domains like learning, controlling the emotions are crucial (Harley et al., 2019). A cognitive path where immersion promoted a positive cognitive value of the activity in keeping with the control value theory of achievement feelings, and an emotional path where immersion predicted presence and good emotions (Makransky & Lilleholt, 2018). Emotions are an unnecessary cognitive load that competes for working memory space by necessitating the processing of information that is irrelevant or unrelated to the activity at hand. The emotion might influence the intrinsic cognitive load, and emotion management is a goal of learning (Plass & Kalyuga, 2019).

Meta-cognitive relates to meta-affective, and meta-affective relates to transformative competencies. These competencies are places where students can collaborate to create a "learning compass" that demonstrates how young people might navigate their lives and the world. Students have the competencies of creating new values, reconciling tensions and dilemmas, and taking responsibility (OECD Directorate for Education and Skills, 2018). Transformational social and emotional learning aims to advance excellence and equity among kids, teens, and adults. Prioritize racial and ethnic issues as a starting point for resolving the wider range of existing imbalances. For developing these skills and emphasizing the value of professional development for adults in making these efforts as successful as possible for different children and youth (Jagers et al., 2019). Highlights the need for a revised approach to education with a focus on the important set of abilities known as the 4Cs (creativity, communication, collaboration, and critical thinking), unpacking the many achievement disparities that are afflicting our society (Soulé & Warrick, 2015).

The discussion in the preceding sentence clarifies the significance of students' metacognitive, meta-affective, and transformative competencies in their learning. Students should take good ownership of this. The reality is that students' meta-cognitive skills are still lacking, specifically their monitoring and evaluating skills (Ijirana & Supriadi, 2018). The metacognitive skills of the students in grades 7, 8, 9, 10, and 11 were all rated as being very low (Fauzi & Saâ, 2019). Research findings on scientific attitudes and metacognitive skills in Indonesia's learning processes are still comparatively low. According to research done in senior high schools, students' metacognitive skills were rated as being below average (Rumahlatu & Sangur, 2019). When composing descriptive texts, high school students showed poor metacognitive knowledge and regulation (Krisdianata & Kuswandono, 2022). Indonesian high school students' attitudes were still relatively low (Nababan et al., 2019). Both male and female students have low level ability in managing their angry feelings (Rusyati et al., 2022b).

As an effort to determine the state of the art of this research, a bibliometric analysis was carried out using Harzing's Publish or Perish and VOSviewer with the database from Google Scholar for 10 years of research from 2010–2020. The results

of this analysis found 993 papers on meta-cognitive, 662 papers on meta-affective, 999 papers on meta-cognitive training, 415 papers on meta-affective training, and 812 papers on transformative competencies. The results of the analysis show that by Network Visualization, the keywords "meta-cognitive," namely "meta-cognitive strategy" and "meta-cognitive belief," are in the most researched cluster. Meanwhile "attitude" and "worry" are clusters that have been little researched and the lines are quite far from meta-cognitive, they are a great opportunity for further research. In network visualization, the keywords "meta-affective," namely "meta-affective strategy" and "affective learning companion," are clusters that have been studied quite a lot. "Memory" is also studied in relation to meta-affective, but this variable has a long line with "teaching" and "course." As a result, meta-affective research on teaching and learning activity is an excellent avenue for future investigation.

Network visualization on the keyword "meta-cognitive training" shows that "meta-cognitive strategy" is the most researched, while "meta-cognitive training" in the second cluster is the most researched but focuses on "schizophrenia." So that meta-cognitive training is a great opportunity for research on teaching and learning activities, especially in science because "memory" and "achievement" also appear in network visualization. Network visualization on the keyword "meta-affective training" shows that "learner" and "strategy" are the most researched clusters, then "meta-affective strategy," "meta-affective awareness," "meta-affective skill," and "meta-affective reflection," which is the second cluster studied but has a long line with "learning," "teaching," and "course." Meanwhile network visualization on the keyword "transformative competencies" shows that "digital transformation," "learning," and "theory" are among the clusters that have been studied a lot, in the second cluster there are "performance," "knowledge," and "transformative learning" that are appearing but not yet investigated for connectivity. So this becomes a gap for current research.

The collection of 30 articles that emphasize meta-cognition in science instruction and have received the most citations in the previous ten years (2009–2019). The publications are published in credible journals and databases like "Google Scholar." The primary tool for this investigation is some sort of coding

system. The conclusion states that research on meta-cognitive tendencies in science teaching is increasingly being done in higher education for pre-service teachers. Focus on the Metacognitive Knowledge (MK) regarding domain-general techniques for science concepts and the Metacognitive Skills (MS) sub-aspect of regulating or controlling for metacognitive features. In the meantime, research on metacognitive concentration is used as the input based on role. The implications of meta-cognitive research trends offer chances to conduct research in lower education for subject-specific science. Additional study can evaluate metacognitive experiences (ME) and metacognitive skills for monitoring, evaluating, and planning of sub-aspects (Rusyati et al., 2021a).

Based on the results of the bibliometric analysis, which show meta-cognitive training and meta-affective training are still not focused on students in learning, especially in science subjects, and are supported by preliminary research that shows the correlation between students' meta-affective and metacognitive is significant with a strong value (Rusyati et al., 2021f), this research, which combines meta-affective and meta-cognitive into one complete training, is a novelty in this study. Meta-cognitive or metacognition refers to the process of thinking, whereas feel or emotion refers to meta-affective. The ability to monitor and control one's thinking and learning is improved by metacognition, which also has a meta-affective dimension for controlling and regulating emotional reactions (Harrison & Vallin, 2018). In the link between stressors and wellbeing, cognitive coping techniques have been found to be crucial (Kraaij & Garnefski, 2019). Since there is a significant correlation between students' meta-affective and metacognitive skills, provide opportunities to develop strategies in science learning to build these skills.

The implementation of the strategy can be done in training sessions, but unfortunately there is still little meta-cognitive and meta-affective training for students, especially in science learning. If anything, they are still separated by themselves, focusing on meta-cognitive or meta-affective processes, even though the two are strongly related. Study which focus on impact of meta-cognitive training has been conducted by Cetin et al. (2014) on comprehension of programming concepts and Karahroudi & Reddy (2014) on writing skills. Meanwhile, studies that focus on the impact of meta-affective training are not yet available, as are studies

on the integration of meta-cognitive and meta-affective training in science learning. Even if there is meta-affective training for healing diseases related to health, it is not part of the learning process. Ultimately need a research to build students' meta-affective and meta-cognitive in science learning by using training program which can assist not only content knowledge but also soft skills. These skills in line with The Future of Education and Skills for Education 2030 that supported by OECD.

Knowledge about thinking is referred to as metacognitive or related to metacognition. Meanwhile "cognitive or cognition" refers to gaining information and comprehension by using mental processes through thought, experience, and the senses, the term "meta" has the meaning "beyond" or "on top of." In the field of education, this technique interacts with students' psychology to take use of their capacity to organize, track, and evaluate effective study methods. Therefore, the result of this behavior is a good learner or thinker. Numerous studies on metacognitive or metacognitive behavior in the sphere of education are alarming. In particular, metacognition or metacognition plays a part as an input or product of research in science education. As the input, strategies meta-cognitive or metacognitive assist students in focusing on achievement, especially in conceptual knowledge about science. These studies, such as on students' science achievement in 7th grade (Akyol et al., 2010), content knowledge for 8th-grade students (Peters & Kitsantas, 2010), physics learning for secondary school students (Moser et al., 2017). Furthermore, metacognition is the significant predictors of science achievement for 7th-grade students (Sperling et al., 2012), there is a very strong relation between the metacognitive and cognitive strategies (Dinsmore & Zoellner, 2018).

Despite, meta-cognitive or metacognition not only serving of students' conceptual knowledge but also this mental process also provides for enhancing of students' skills. Abd-El-Khalick & Akerson (2009) describes that there is the influence of metacognitive training on pre-service elementary teachers' conceptions of Nature of Science (NOS). Moreover, Akerson & Donnelly (2008) findings that cultural values, self-efficacy, attitudes toward teaching science, and metacognitive awareness all have correlations with NOS viewpoints. Metacognitive instruction provide the positive effects on students' problem solving skills (Safari

& Meskini, 2016). Metacognition can increase the effectiveness of inquiry-based science education (Bruckermann et al., 2017; Zhang et al., 2015). The metacognitive evaluation instruction improved all explanation components (scientific explanations), especially claims and reasoning (Wang, 2015). In the contemporary digital environment, it is possible to integrate meta-cognitive strategy training into instruction, which can enhance students' awareness of self-study (Xiao et al., 2022). Through online tutorials, metacognitive and cognitive SRL strategies can be educated. Before and after the online tutorial, there was a substantial change in the SRL and learning outcomes for the students (Rahayu et al., 2018).

Scientific texts are being important as a source in science learning. Hence, meta-cognitive or metacognition instruction can be using as strategy for reading. Michalsky et al. (2009) investigates about meta-cognitive instruction before reading, during reading, and after reading for 4th-grade students. The comprehension of science text was affected by metacognitive awareness. Students' comprehension of the adapted scientific articles and ability to control their learning were both increased by high-intensity Context-based Learning (CBL) and metacognitive prompts. In addition to source learning, several research also focus on the creation of tools for metacognition (Dori et al., 2018). Cooper & Sandi-Urena (2009) provides a robust, reliable, and valid instrument of Metacognitive Activities Inventory (MCAI) to assess meta-cognitive skillfulness in chemistry problem solving and Taasoobshirazi & Farley (2013) constructs of the Physics Metacognition Inventory including knowledge of cognition, planning, monitoring, evaluation, debugging, and information management. In order to mitigate the text-belief consistency impact in multiple text comprehension, metacognitive strategy training concentrating on belief-biasing validation processes is recommended. Readers are better prepared for the difficulties of understanding belief-relevant multiple texts with training that focuses on belief-biasing validation processes, but approaches that encourage receptive information processing are insufficient in the context of hotly debated themes (Abendroth & Richter, 2021).

As the output, the study try to design an approach and learning strategy to improve students' meta-cognitive or metacognition. In order to successfully navigate the upcoming years, four metacognitive skills seem essential. These

include an integrative strategy, information management, a broad approach, and proactive thinking (Riney, 2021). For students' metacognitive skills empowerment, there are several teaching strategies namely Problem Based Learning (PBL) (Palennari, 2016; Tosun & Senocak, 2013). The PBL integrated with Jigsaw (PBL-Jigsaw) strategy's regression line was in the best possible position. It showed that this strategy has the potential to strengthen metacognitive abilities while also boosting cognitive retention (Palennari, 2016). Comparing students with weak and strong science backgrounds, PBL was more successful in raising the levels of metacognitive awareness in the latter group. The results also demonstrated that PBL was successful in boosting students' favorable attitudes toward chemistry who had little prior exposure to the subject (Tosun & Senocak, 2013). Furthermore, students' affective as the results of treatment in teaching and learning. The majority of the students showed good emotions, which may be related to how they saw themselves in connection to the process and the numerous scaffolds set up. It may be possible to increase students' feedback literacy and our awareness of the function of emotions in peer feedback by learning which feelings students experienced during peer feedback (Bharuthram & van Heerden, 2022).

The student's meta-affective learning was crucial to students' understanding during science class (Radoff et al., 2019). Furthermore, Uzuntiryaki-Kondakci & Kirbulut (2016) has been developed Meta-Affective Trait Scale (MATS) to measure the meta-affective inclinations related to emotions that students have while they are studying for their classes. Kirbulut & Uzuntiryaki-Kondakci (2019) indicates that science self-efficacy partially mediated the relationship that meta-conceptual regulation and affective regulation have with science achievement. Although the teachers are able to describe affective objectives in behavioral terms and have a basic understanding of the guidelines for creating affective test items, they do not instruct students in the affective domain (Appau et al., 2022). Based on these facts, meta-cognitive or metacognition not only support students for developing their achievement on content knowledge of science but also skills such as problem solving, inquiry, scientific explanations and nature of science. Moreover, meta-affective provide strategy for monitoring and regulating students' emotion. This is in line with The Future of Education and Skills: Education 2030

that supported by OECD. These skills for instance the adaptability, curiosity, communication skills, collaboration skills, global mind-set, open mind-set, reflective thinking, and self-awareness, self-regulation, and self-control (OECD Directorate for Education and Skills, 2018).

1.2 Research Problem

Based on explanation in the background, research problem of this study is: *"How effective is meta-affective and meta-cognitive-based training for achieving the students' meta-affective, meta-cognitive, and transformative competencies in science learning?".* Furthermore, to further clarify the study, the research problem is elaborated in the following research questions:

1. Is there a different of meta-affective in groups of students who are given separate training and integrated training in meta-affective and meta-cognitive strategies?
2. Is there a different of meta-cognitive in groups of students who are given separate training and integrated training in meta-affective and meta-cognitive strategies?
3. Is there a different of transformative competencies in groups of students who are given separate training and integrated training in meta-affective and meta-cognitive strategies?

1.3 Operational Definition

An operational definition is a description of something in terms of the activities, processes, or procedures that could be used to observe and measure it. Consequently, the research variables have four operational definitions, namely meta-affective, meta-cognitive, and transformative competences are the dependent variables, whereas meta-affective and meta-cognitive-based training is the independent variables. The operational definitions in this research are listed as follows:

1. Training that is based on the meta-affective and meta-cognitive dimensions and uses ten meta-affective and ten meta-cognitive strategies is known as meta-affective and meta-cognitive-based training. Students can participate freely in this training (separate training) or receive assistance from teachers (integrated

training). An observation sheet was used to track the effectiveness of this program.

2. Meta-affective tendencies are a quality that students have in relation to their emotions while studying for their classes. Meta-affective is formed when the affective awareness and affective regulation dimensions combine. To assess students' meta-affective, a questionnaire was used with a six-point scale, namely: never (1), rarely (2), sometimes (3), often (4), mostly (5), and always (6).
3. Meta-cognitive is the capacity to take one's own current cognitive processes into account. Two essential elements of meta-cognitive are knowledge of cognition and regulation of cognition. The questionnaire response is frequency on a scale of never (1), rarely (2), sometimes (3), often (4), mostly (5), and always (6).
4. Transformative competencies refer to The OECD Learning Framework 2030 which consist of three competencies, namely creating new value, reconciling tensions and dilemmas, and taking responsibility. To assess students' transformative competencies, a questionnaire was used with a five-point scale, namely: not at all typical of me (1), not very typical of me (2), somewhat typical of me (3), fairly typical of me (4), and very typical of me (5).

1.4 Limitation of Problem

Limitation of problem refers to the problem's scope or an effort to reduce the problem's scope that is too vast or wide so that research can be conducted with more precision. To make this research more concentrated and targeted within a certain field, the problem is limited to a few specific topics. Firstly, the strategy used in this research is meta-affective and meta-cognitive-based training. There are two types of training, namely integrated and separate training. Both types of training consist of 20 strategies, composed of 10 meta-affective strategies and 10 meta-cognitive strategies. The difference between the two trainings is that in integrated training, the twenty strategies are implemented by students with the assistance of the teacher during science learning, while in separate training, students implement them independently during science learning. Prior to learning, the researchers trained teachers who facilitated the integrated training and students in separate training on these strategies. All training and learning is carried out through online meetings,

following government and school policies regarding learning during the COVID-19 period.

Secondly, this study's definition of meta-affective is restricted to affective awareness and affective regulation data gathered from questionnaires administered during the initial and final phases of learning. The students' self-evaluations, not the teacher's or observer's, are what led to the collection of the meta-affective data. Therefore, students' perceptions of affective awareness and affective regulation are solely based on their experiences after putting training strategies for meta-affective and meta-cognitive training into practice. Thirdly, the concept of meta-cognitive in this study is limited to information on cognition's regulation and knowledge from questionnaires given during the initial and final stages of learning. The meta-cognitive data was gathered as a result of the students' self-evaluations, not those of the teacher or observer. As a result, students' assessments of their understanding of cognition and ability to control it are purely based on their experiences using training strategies for meta-affective and meta-cognitive training. Fourthly, the definition of transformative competencies used in this study is limited to three competencies: (1) creating new value, (2) reconciling tensions and dilemmas, and (3) taking responsibility. These competencies were identified through questionnaires given out during the initial and final phases of learning. The data on transformative competencies was gathered as a result of student self-evaluations rather than assessments made by the teacher or an observer. Because of this, how students perceive transformative competencies is solely based on their observations after putting training techniques for meta-affective and meta-cognitive training into practice.

There are 10 meta-affective strategies that can be applied by students during science learning, namely: (1) Students identify their feelings, (2) Students must examine themselves objectively in order to manage compliments, feedback, and criticism, (3) Students embrace their strengths and acknowledge their weaknesses, (4) Students understand that self-work and growth are positive activities, (5) Students write a list of the things they like about themselves, (6) Discuss how thoughts lead to actions and actions to feelings, which lead once again to thoughts, (7) Students are to construct a personal emotion journal and discuss it, (8) Clarifying

the personal emotion journal, (9) Students fortify their belief in themselves, and (10) Students set a realistic goal and write down steps they can take to meet that goal. There are 10 meta-cognitive strategies that can be applied by students during science learning, namely: (1) Discuss how students live a happy life, (2) Discuss how students become respected human beings, (3) Discuss how students feel good about themselves, (4) Give a few tips about active listening, (5) Students write down three key ideas from the lecture, (6) Students construct a personal learning journal, (7) Clarifying the personal learning journal, (8) Students do combine the test by using short or long essay questions, (9) Students reflect on coursework, and (10) Students learn to recognize what they do not understand.

1.5 Research Objective

This research objective is to analyze the effectiveness of meta-affective and meta-cognitive-based training for achieving the students' meta-affective, meta-cognitive, and transformative competencies in science learning. Moreover, the research output is a training program for assisting students in utilizing meta-affective and meta-cognitive processes for successful science learning. Hopefully, meta-affective and meta-cognitive management by students can help them to survive in the future life which in line with The Future of Education and Skills for Education 2030 that supported by OECD. These skills for instance the adaptability, curiosity, communication skills, collaboration skills, global mind-set, open mind-set, reflective thinking, and self-awareness, self-regulation, and self-control.

1.6 Research Benefit

This research is very important to serve students for exploring their meta-affective and meta-cognitive during learning science. For students, they get experience how to use meta-affective and meta-cognitive during learning science. Moreover, they can oversee their meta-affective and meta-cognitive in order to positive motivation and reflection in learning. Finally, students become independent learners. For teachers, the science learning strategies as the output of this research can be implemented for other students. Furthermore, teachers not only transfer the science knowledge but also as a students' facilitator to raise meta-

affective and meta-cognitive in science learning. For another researcher, the research results can be basic for further research in different contexts, content or students level. Additionally, reevaluate the strategies used in this study or add different kinds of strategies to fill in the gaps. For Institutions (Higher Education), the findings can be as the proposal for preparing pre-service teacher to teach science by using meta-affective and meta-cognitive approach. In addition, it could be a comparison study on how to implement meta-affective-based learning, which has not been formally addressed in the classroom up to now but is assessed by the teacher.

1.7 Organizational Structure of Dissertation

In order to build a coherent framework for the dissertation, this section offers a methodical outline of the content of each chapter, the sequence in which it is written, and the connections between individual chapters. The introduction in Chapter I is broken down into numerous sections that explain the research background, the research problem that is broken down into several research questions, the limitation of the problem, the research objective, and the research benefit. Additionally, operational definitions for the variables are discussed in this chapter. All of the theoretical justifications from diverse reference materials are presented in the literature review in a logical order. The focus of Chapter II is on the ideas that were employed in the study. The research's various factors all came into play one by one to support the case for students' meta-affective, meta-cognitive, and transformative competencies.

The research methodology serves as the primary emphasis of Chapter III, which explains the general research processes and procedures. The research design, the population involved, the samples used, the hypotheses and assumptions, are just a few of the highlights. Additionally, the methods employed to analyze the research data and the research instruments used. The data that was acquired throughout the data collection procedure is described in Chapter IV, which is devoted to the results and discussion. The raw data was evaluated and discussed using different statistical methods to get a precise set of results and make it simpler to interpret the final data. The focus data being interpreted is whether there are any differences in students'

meta-affective, meta-cognitive, and transformative competencies across groups receiving integrated and separate training in the initial and final conditions. Finally, Chapter V includes a conclusion, implications, and recommendation that summarizes the information gathered. This chapter also outlines recommendations and ideas for additional research that take the limitations of this study into account.