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Article

From Online to In-Person: Students' Motivation and Self-Regulation in Science Teaching Activities During and After the COVID-19 Pandemic

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ABSTRACT

This study aims to find out the differences in students' motivation and self-regulation in science teaching activities during and after the COVID-19 pandemic and the strengths and weaknesses of science teaching activities during and after the COVID-19 pandemic from students' perceptions to improve students' engagement and achievement in science. This study used a survey design involving 469 junior high school students from 7th, 8th, and 9th grades from 30 different schools located in West Java, East Java, West Nusa Tenggara, Central Java, Special Capital Region of Jakarta, Riau, and East Kalimantan. The instrument consisted of an adapted version of the SALES Questionnaire with a 5-point Likert scale and open-ended questions. Data analysis was carried out by quantitative and qualitative methods. The results showed that students' motivation and self-regulation in science teaching activities during and after the COVID-19 pandemic were significantly different. The strengths of science teaching activities during the COVID-19 pandemic are flexibility, fewer distractions, and the availability of more learning resources, while the weaknesses are a lack of explanation and understanding, uninteresting, limited interaction, and limited practical activities. The strengths of science teaching activities after the COVID-19 pandemic are clearer explanations, availability of practical activities, and ease of interaction, while the weaknesses are distractions from peers, limited learning resources, and boring. The findings from this study provide an opportunity for science teachers to plan and implement effective learning strategies to increase students' motivation and self-regulation to improve their engagement and achievement in science.

INTRODUCTION

Motivation is an internal force that affects and encourages an individual's thoughts, feelings, and goal-oriented behavior (Mubeen & Reid, 2014). According to Metaj-Macula and Bytyqi-Damoni (2020), motivation is energy, direction, reasons for an individual's behaviors, what he does, and why he does that. Motivation is one aspect that encourages individuals to do

particular activities to attain a goal (Mat et al., 2017). One of the activities that are influenced by motivation is learning as stated by Kuo et al. (2019) there is a significant correlation between students' motivation towards learning and their academic achievement.

Dong et al. (2019) explained that based on the social cognitive theory proposed by Bandura (1986) motivation is the personal characteristics that influence an individual's behavior. In terms of science teaching activities, motivation is an internal characteristic of an individual to generate and maintain his behaviors in science teaching activities. Students' motivation in science teaching activities is defined as internal conditions that enhance, provide direction, and maintain students' behavior in science teaching activities (Dong et al., 2019). When students have a high level of motivation, they are more likely to be involved in science-related teaching activities (Dong et al., 2019). Thus, to improve students' engagement in science, it is important to examine students' motivation in science teaching activities.

Three components of motivation are consistently associated with the adaptive motivational beliefs of students: learning goal orientation, task value, and self-efficacy, all three are essential to effective participation in self-regulated learning (Velayutham et al., 2011). This is in line with the definition of science motivation stated by Smart (2014) which is science motivation is defined by theories of goal orientation, expectancy-value, and self-efficacy. Students' values, attitudes, and conceptions toward a specific academic domain were reflected by their subject-specific motivation (Smart, 2014) which indicates that the science motivation of an individual represented students' values, attitudes, and conceptions toward science.

Goal orientation was defined as achievement goals (Smart, 2014) which is represented by performance goal orientations or mastery goal orientations (Aoyagi et al., 2020). Performance goal orientations are indicated by student focus on competition, comparison with other students, and showing competence (performance-approach) or avoiding failure (performance-avoid) (Smart, 2014) and it assigns importance to outperforming other students (Smart, 2014). Mastery goal orientations are represented by students focusing on their personal progress, development, and learning for learning's sake (Smart, 2014). While students with a learning goal orientation place more emphasis on developing their competence, those with a performance-goal orientation are more concerned with performing well and proving their competence to others (Gjerde et al., 2022). According to the expectancy-value theory, an individual's motivation is a result of their value for the task and their expectation of success in it (Smart, 2014) which task value can be used as an individual's preference/resolution prediction and expectancy for success can be used as individual's performance prediction (Smart, 2014).

Self-efficacy is an optimistic self-belief in overcoming challenges and completing tasks or goals with a positive mindset (Wang, 2021). Self-efficacy relates to students' academic motivation (Smart, 2014) and has a positive correlation with their achievement (Smart, 2014). Specifically, according to Smart (2014), students who are convinced of their competence in science teaching activities have a higher possibility to take on difficult tasks, stick with them, and give both successful and failed constructive explanations.

Self-regulation is a process that students employ to activate and maintain their cognitions, emotions, and behaviors to achieve their personal goals (Zimmerman & Kitsantas, 2014). Based on the social cognitive theory, self-regulated learning is a proactive, constructive process whereby students set learning objectives and then work to monitor, regulate, and control their thinking, motivation, and behavior, constrained and guided by their objectives and the environmental context (Yerdelen & Sungur, 2019). Many researchers believed that metacognitive self-regulation was particularly important for academic learning because it reflected students' awareness, knowledge, and control of cognition and could improve how effectively they applied cognitive strategies (Li et al., 2018). Self-regulatory functions involve students' self-generated perceptions, affections, and actions toward achieving their goals (Aldridge & Rowntree, 2022). Previous research showed that self-regulated learning is more

likely used by high-achieving students than low-achievers (Yerdelen & Sungur, 2019). Therefore, to improve students' achievement, it is important to examine students' self-regulation (Yerdelen & Sungur, 2019).

Nowadays, in the science inquiry context, students usually jump straight into the inquiry environment with the learning tasks and several tools such as how hands hold devices and lab equipment, yet do not receive any pedagogical guidance (Lai et al., 2018). In addition, students might put a lot of time and effort into evaluating and determining the value of the information they find (Mason et al., 2013). Lai et al. (2018) stated that in this situation, learner control, which is linked to students' self-regulation and the strategies they employ, is crucial to their science inquiry processes.

The World Health Organization (WHO) declared the COVID-19 pandemic on March 11, 2020 (Onyeaka et al., 2021). The COVID-19 pandemic has caused the greatest historical disruption to educational systems nearly 1.6 billion students across nearly 190 countries and all continents have been impacted by the school and other learning space closures, which have affected 94% of the world's student population, rising to 99.4% in low and lower-middle-income countries (United Nations, 2020). This pandemic forced schools in many countries to transition from in-person learning to online learning (Calamlam, 2023; Moore, 2022; Moorhouse & Kohnke, 2021). Online/virtual learning which was adopted by many parts of the world throughout the pandemic (Dehghan et al., 2022) defined as a setting for learning where teachers and students are apart from one another either in terms of time or location or both (Tabatabai, 2020).

Virtual/online learning has its advantages and disadvantages as stated by Bączek (2021) the advantages are learning at home, being able to learn at the student's own pace, class interactivity, being able to record the learning session, and comfortable surroundings. The disadvantages are technical problems, unsupported learning conditions at home, lack of self-discipline, and isolation from society. According to Dehghan et al. (2022), some studies showed the result of online learning implementation during the COVID-19 pandemic as the replacement of in-person learning: changing from in-person learning to online learning generated in students' academic decline and students' academic achievement decreased when the complexity of the lesson getting higher which it was connected to students' self-regulation which is stagnant during online class; online learning was not always engaging; and the students assured that the difficulty increased when learning was held online and they also experienced lack of support resources.

Many previous studies related to motivation and self-regulation. Vedder-Weiss and Fortus (2018) studied the relationship between science teachers' instruction and students' motivation in science teaching activities and school culture. The study results showed that the decreasing emphasis on mastery goals by schools and science teachers results in decreasing adolescents' motivation for science teaching activities (Vedder-Weiss & Fortus, 2018). Mustami (2019) showed that motivation and learning outcomes are directly correlated with self-adjustment, social support, and self-regulation. Kuo et al. (2019) examined low and non-low achievers' motivation toward science teaching activities under inquiry-based instruction and the results indicated that non-low achievers' achievement goals and opinions of their learning environment significantly improved compared to those in the control group. Martinek et al. (2016) found that academic self-regulation is negatively correlated with age, while intrinsic and (rather) controlled regulation decreased as students aged.

Other studies showed in science teaching activities, perceived classroom learning environment factors were reliable indicators of students' self-regulation (Yerdelen & Sungur, 2019). Velayutham and Aldridge (2013) represented the strongest indicators of students' motivation and self-regulation in science teaching activities were student task orientation, inquiry, and cohesiveness. Aldridge and Rowntree (2022) showed how the psychosocial learning environment affects female students' motivation toward science as well as how that

motivation affects their self-regulatory behavior in science classroom settings. Another study that also had an interesting result was a study by Koksal (2014) which indicated that logical thinking, IQ verbal, IQ performance, IQ total, and critical thinking scores did not significantly predict how motivated gifted elementary school students were to learn science.

There were studies specifically related to COVID-19. Pelikan et al. (2021) studied the role of self-regulated learning (SRL), motivation, and procrastination for perceived competence while distance learning during COVID-19. The findings showed that when compared to students who felt less competent, students who felt highly competent used SRL strategies (goal setting and planning, time management, and metacognitive strategies) more frequently, were more intrinsically motivated, and procrastinated less. Qualitative analysis also revealed that even though all students face similar challenges such as independent learning, time and task management, learning on the computer, and lack of contact with teachers and peers, those who felt highly competent seemed to cope better and needed less support (Pelikan et al., 2021a). Biwer et al. (2021) studied students' adaptation to emergency remote learning during COVID-19 by focusing on their resource-management strategies using a different approach for each individual which the results indicated that students were less motivated and less able to control their attention, effort, and time compared to before the COVID-19 began. They also reported spending more time and effort on their self-study (Biwer et al., 2021).

Nguyen (2021) studied the correlation between obstacles of online class and students' motivation during COVID-19 pandemic, do motivation-boosting strategies help students cope with challenges in online class duration and have an impact on their academic achievement or not. The findings showed that the impact of extrinsic barriers on the motivation of online class is greater than intrinsic barriers. The biggest factor of intrinsic motivation that encourages students to learn is awareness of the importance of the subject and the instructor's teaching methods, while the lowest factor is their confidence in using the technology of e-learning. The biggest factor in extrinsic motivation is the stimulation they get to work hard, including innovative methods used in teaching activities, well publishing and storing material, an abundance of knowledge sources that can be accessed easily online, saving time, as well as assessment and appreciation from teachers and students. The results from this study also showed that the motivation-boosting activities during online class have a positive influence on students' motivation and academic achievement. However, that study investigated non-science subject teaching activities which means is not related to science teaching activities.

Willoughby et al. (2024) showed that the COVID-19 pandemic negatively impacted students' learning motivation on science specifically in the field of anatomy. The COVID-19 pandemic accelerated the development of online teaching activities with both positive and negative connotations. The results also indicated that there were no statistically significant differences in learning motivation between the level of study or gender. They investigated the comparison of students' motivation between the level of study and gender which is not covered by this study. Another study conducted by Yang et al. (2020) investigated the influence of self-efficacy and cognitive anxiety on science engagement. They used game-based learning based on smartphones which was applied to science teaching activities during the COVID-19 pandemic. The results showed that science students' learning engagement was positively affected by their self-efficacy and negatively affected by their cognitive anxiety. The results indicated that science learning self-efficacy provides a viable way for students to increase their engagement in science learning, especially in online learning after the COVID-19 pandemic. They only studied students' self-efficacy in science teaching activities during the COVID-19 pandemic and did not covered their self-efficacy after the COVID-19 pandemic.

Although there have been many previous studies on students' motivation and self-regulation as there were researchers who have covered it, in the COVID-19 context, there is no research that compares students' motivation and self-regulation specifically in science teaching activities during and after the COVID-19 pandemic. During the COVID-19 pandemic, a sudden

transition to online learning occurred in many countries, especially in Indonesia (Hidayati & Saputra, 2020). After the COVID-19 pandemic, online learning switched to in-person learning (Nemeth et al., 2023). It showed differences in science teaching activities during and after the COVID-19 pandemic. This study aims to find whether those differences affect students' motivation and self-regulation in science teaching activities during and after the COVID-19 pandemic as previous studies showed that motivation and self-regulation can affect their academic performance and achievement in science.

This study aims to explore some questions below.

1) Are there differences in students' motivation and self-regulation in science teaching activities during and after the COVID-19 pandemic?
2) What are the strengths and weaknesses of science teaching activities during and after the COVID-19 pandemic from students' perceptions?

METHODS

This study used a non-experimental quantitative design in which manipulation of variables was not involved (Starbuck, 2023). A survey was used to explore if there were any differences in Indonesian junior high school students' motivation and self-regulation in science teaching activities during and after the COVID-19 pandemic (Creswell, 2012). This study was conducted from April to June 2023.

This study involved 469 junior high school students from grades 7-9, aged 12-16. 262 participants (55.9%) were girls and 207 (44.1%) were boys. 78 participants (16.6%) were from grade 7, 312 participants (66.5%) were from grade 8, and 79 participants (16.8%) were from grade 9. They were from 30 different schools located in six provinces which 437 participants (93.2%) were from West Java, 9 participants (1.9%) were from East Java, 8 participants (1.7%) were from West Nusa Tenggara, 6 participants (1.3%) were from Central Java, 6 participants (1.3%) were from the Special Capital Region of Jakarta, 2 participants (0.4%) were from Riau, and 1 participant (0.2%) were from East Kalimantan. According to Ministry of Health Republic Indonesia (2022), East Java, Central Java, the Special Capital Region of Jakarta, and West Java are included in the five provinces with the highest positive trend for COVID-19. This study followed purposive sampling which the sample that meets the requirements was directly chosen. This technique was used because it has a better match between the sample and the research objectives which improves the accuracy of research and confidence in the data and results (Campbell et al., 2020).

The instrument used in this study was adapted from the Students' Adaptive Learning Engagement in Science (SALES) Questionnaire that was originally developed by Velayutham et al. (2011). The instrument is composed of four sets of factors: learning goal orientation, task value, self-efficacy, and self-regulation. According to Velayutham et al., 2011, a minimum of 0.80 is required for a 'good' scale based on convention. The Cronbach alpha coefficient for each factor is more than 0.90 with details of learning goal orientation (0.91), task value (0.92), self-efficacy (0.92), and self-regulation (0.91). This provides an indication of the internal consistency reliability of the questionnaire. The original version contains 32 items with a 5-point Likert scale. The adapted version contains 64 items with a 5-point Likert scale which consists of four aspects: learning goal orientation, task value, self-efficacy, and self-regulation, and 4 items in the form of open-ended questions which consist of two indicators: advantages and disadvantages of science teaching activities. The adapted version consists of two parts which refer to science teaching activities during the COVID-19 pandemic and science teaching activities after the COVID-19 pandemic. Each part contains 32 items with a 5-point Likert scale and 2 open-ended questions. Thus, 32 items and 2 open-ended questions for science teaching activities during the COVID-19 pandemic and 32 items and 2 open-ended questions for science teaching activities after the COVID-19 pandemic. The instrument was shared with the participants through Google Forms. Items with a 5-point Likert scale consisting of five

possible responses which are 1 (*Strongly disagree*), 2 (*Disagree*), 3 (*Neutral*), 4 (*Agree*), and 5 (*Strongly agree*). Whereas the responses to open-ended questions vary which requires the categorization process.

Data collected were analyzed statistically by using Microsoft Excel 2019 and IBM SPSS Statistics 29.0.1.0. Microsoft Excel was used to analyze two means by using charts. The data from items with a 5-point Likert scale was separated into two categories which one belonging to during the COVID-19 pandemic and another belonging to after the COVID-19 pandemic. The general average of all aspects during the COVID-19 pandemic and after the COVID-19 pandemic was calculated. To calculate each aspect's mean, each category's data was separated into four as there are four aspects for items with a 5-point Likert scale. Then SPSS is used to run the Wilcoxon Signed Ranks test to determine whether there were significant differences in means during and after the COVID-19 pandemic both overall and in each aspect. Microsoft Excel was also used to analyze the categorized answers to open-ended questions. Participants' answers to open-ended questions were categorized based on their similarity of meanings and were analyzed to arrange the answers given most by them down to the fewest. The sample items can be seen in Table 1.

Table 1. The sample items of the instrument was used in this study

Aspect	**Statement**	**Scale**				
		5 (Strongly agree)	**4 (Agree)**	**3 (Neutral)**	**2 (Disagree)**	**1 (Strongly disagree)**
Learning Goal Orientation	In science class, one of my goals is to learn as much as possible during the COVID-19 pandemic (online class).					
Task Value	In science class, what I learned I can apply in my daily life during the COVID-19 pandemic (online class).					
Self-Efficacy	In science class, I can master the skills taught during the COVID-19 pandemic (online class).					
Self-Regulation	In science class, even when assignments are not interesting, I still do them during the COVID-19 pandemic (online class).					

RESULTS AND DISCUSSION

There is a mean difference of all aspects during and after the COVID-19 pandemic as can be seen in Figure 1.

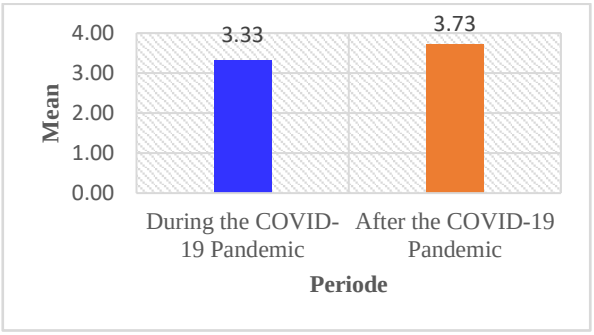

Figure 1. Mean Difference in All Aspects During and After The COVID-19 Pandemic

The results shown in Figure 1 indicated that the mean of all aspects after the COVID-19 pandemic (3.73) was larger than during the COVID-19 pandemic (3.33). Moreover, there is a mean difference in each aspect during and after the COVID-19 pandemic as can be seen in Figure 2.

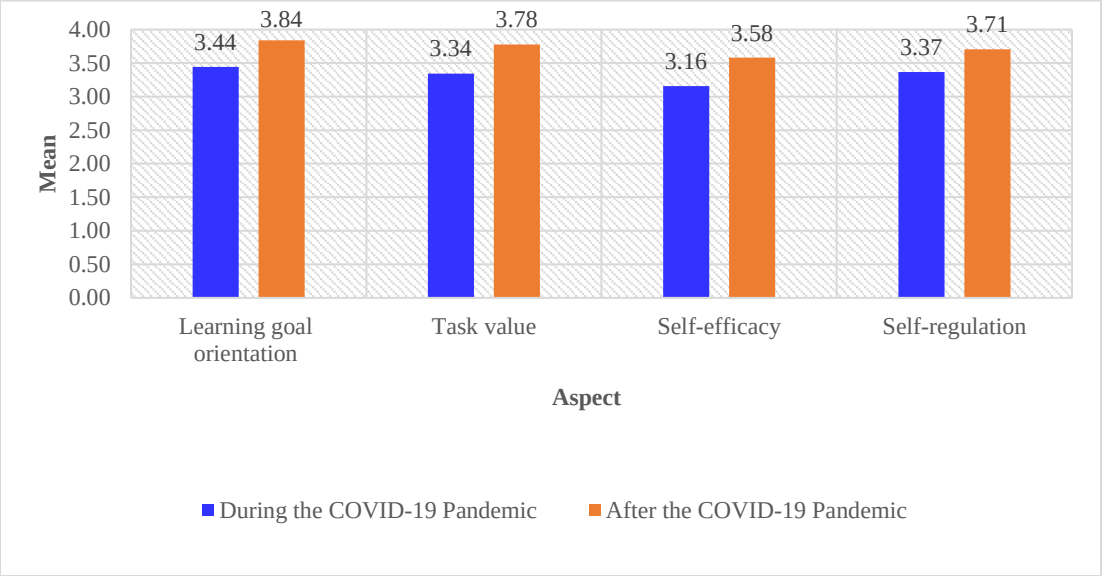

Figure 2. Mean Difference in Each Aspect During and After The COVID-19 Pandemic

The results shown in Figure 2 pointed out that the mean of learning goal orientation after the COVID-19 pandemic (3.84) was greater than during the COVID-19 pandemic (3.44). The mean of task value after the COVID-19 pandemic (3.78) was greater compared to during the COVID-19 pandemic (3.34). The mean of self-efficacy after the COVID-19 pandemic (3.58) was larger than during the COVID-19 pandemic (3.16). The mean of self-regulation after the COVID-19 pandemic (3.71) was also greater than during the COVID-19 pandemic (3.37). It showed that the mean of each aspect after the COVID-19 pandemic was larger than during the COVID-19 pandemic. It indicated there are differences in students' motivation and self-regulation in science teaching activities during and after the COVID-19 pandemic, both overall and in each aspect. To know whether the difference is significant or not, the Wilcoxon Signed Ranks test was conducted in this study. The result of the Wilcoxon Signed Ranks test for all aspects of students' motivation and self-regulation in science teaching activities during and after the COVID-19 pandemic can be seen in Table 2.

Table 2. The result of the Wilcoxon Signed Ranks Test for All Aspects of Students' Motivation and Self-Regulation in Science Teaching Activities During and After The COVID-19 Pandemic

Ranks					Asymp. Sig. (2-tailed)
		N	Mean Rank	Sum of Ranks	
After - During	Negative Ranks	77[a]	126.68	9754.50	<0.001
	Positive Ranks	339[b]	227.08	76981.50	
	Ties	53[c]			
	Total	469			

a. After < During
b. After > During
c. After = During

It can be seen from the results shown in Table 2 that the mean rank of positive ranks of all aspects (227.08) was greater than the mean rank of negative ranks (126.68). The result also showed that the sum of ranks of positive ranks of all aspects (76981.50) was larger compared to the sum of ranks of negative ranks (9754.50). The Wilcoxon Signed Ranks test was also

conducted for each aspect of students' motivation and self-regulation in science teaching activities during and after the COVID-19 pandemic which the result can be seen in Table 3.

Table 3. The result of the Wilcoxon Signed Ranks Test for Each Aspect Of Students' Motivation and Self-Regulation in Science Teaching Activities During and After The COVID-19 Pandemic

Aspect	Ranks					Asymp. Sig. (2-tailed)
			N	Mean Rank	Sum of Ranks	
Learning goal orientation	After - During	Negative Ranks	77[a]	131.95	10160.00	<0.001
		Positive Ranks	292[b]	198.99	58105.00	
		Ties	100[c]			
		Total	469			
Task Value	After - During	Negative Ranks	68[a]	123.01	8365.00	<0.001
		Positive Ranks	301[b]	199.00	59900.00	
		Ties	100[c]			
		Total	469			
Self-efficacy	After - During	Negative Ranks	90[a]	132.01	11881.00	<0.001
		Positive Ranks	286[b]	206.28	58995.00	
		Ties	93[c]			
		Total	469			
Self-regulation	After - During	Negative Ranks	80[a]	131.98	10558.00	<0.001
		Positive Ranks	274[b]	190.79	52277.00	
		Ties	115[c]			
		Total	469			

a. After < During
b. After > During
c. After = During

The result shown in Table 3 is that the mean rank of positive ranks for learning goal orientation (198.99) was larger than the mean rank of negative ranks (131.95). The mean rank of positive ranks for task value (199.00) was larger compared to the mean rank of negative ranks (123.01). The mean rank of positive ranks for self-efficacy (206.28) was greater than the mean rank of negative ranks (132.01). The mean rank of positive ranks for self-regulation (190.79) was larger than the mean rank of negative ranks (131.98). The results indicated that the mean rank of positive ranks for each aspect after the was larger than the mean rank of negative ranks.

From Table 3, the results showed that the sum of ranks of positive ranks for learning goal orientation (58105.00) was greater than the sum of ranks of negative ranks (10160.00). The sum of ranks of positive ranks for task value (59900.00) was larger compared to the sum of ranks of negative ranks (8365.00). The sum of ranks of positive ranks for self-efficacy (58995.00) was greater compared to the sum of ranks of negative ranks (11881.00). The sum of ranks of positive ranks for self-regulation (52277.00) was larger compared to the sum of ranks of negative ranks (10558.00). The results pointed out that the sum of ranks of positive ranks for each aspect was greater than the sum of ranks of positive ranks. From Table 2 and Table 3, the results showed that there are significant differences both overall and in each aspect during and after the COVID-19 pandemic (p <0.001).

There were statistically significant differences in students' motivation and self-regulation in science teaching activities during and after the COVID-19 pandemic. The differences were found in all four aspects which are learning goal orientation, task value, self-efficacy, and self-regulation. It showed that after the COVID-19 pandemic, students have higher levels of learning goal orientation, task value, self-efficacy, and self-regulation in science teaching activities compared to during the COVID-19 pandemic. Each of the four aspects will be discussed below.

Students' motivation consisted of three aspects which are learning goal orientation, task value, and self-efficacy (Velayutham et al., 2011). The results showed that compared to during the COVID-19 pandemic, the mean of students' learning goal orientation, task value, and self-efficacy in science teaching activities after the COVID-19 pandemic were larger. It indicated that after the COVID-19 pandemic, students have higher motivation compared to during the COVID-19 pandemic. As the strengths of science teaching activities after the COVID-19 pandemic stated by the students who participated in the present study, this might be caused by the explanations they got from in-person learning being clearer and more detailed which helped them to have a good understanding of the lesson. Other than that, the learning method, learning environment, and learning sources during in-person classes supported students' motivation increased compared to online classes during COVID-19. During the COVID-19 pandemic, online learning which had a less structured learning environment required students to be more independent in regulating their learning and motivation (Klingsieck et al., 2012).

The first aspect that will be discussed is learning goal orientation. Learning goal orientation refers to individual development related to performance, motivation, well-being, cognitive abilities (Tippin et al., 2012), and personality traits (Sánchez-Cardona, 2020). According to Sánchez-Cardona (2020), learning goal orientation is related to psychological constructs including self-efficacy, motivation, enjoyment, well-being, and satisfaction. Learning goal orientation is associated with defining more advanced goals and preserving higher performance from time to time (Taing et al., 2013). During the COVID-19 pandemic, students did not enjoy the science lessons, and online learning negatively affected their well-being **(**Shakil et al., 2022) which impacted their learning goal orientation. After the COVID-19 pandemic, students stated that they enjoyed being involved in science teaching activities. Through in-person classes, their interaction with their peers and teachers is not limited to online learning which can be related to the well-being they have when they socialize.

The second aspect is task value. Task value beliefs with expectancy beliefs as two core sets of beliefs indicate how productive students' engagement with the task given and what they might acquire from that experience afterward (Crippen et al., 2022). When a task is given to students, they will subconsciously ask themselves questions that refer to those beliefs: "*Can I do this? And why do I want to do this?*" which the first question involves their expectancy beliefs while the second question involves their subjective task value beliefs (Crippen et al., 2022). According to Crippen et al. (2022), by giving the option to students, they are more likely to complete the task given when they expect to be successful and recognize the value in spending their effort and time.

During the COVID-19, science teaching activities felt boring and most students felt they didn't understand the lesson they were studying because they didn't get enough explanations from their teachers. When they didn't understand the lesson, the tasks given would make students feel even more confused. This resulted in them feeling the tasks given were difficult and became a burden to them. In the end, students did not have a strong desire to complete the tasks given, or even if they did, they did it carelessly. After the COVID-19 pandemic, students found it easier to do the tasks given because they had already understood the lesson. During in-person learning, the access to ask questions both to teachers and peers is available which can be a factor in students feeling easy and enjoying doing the tasks given.

As previous research, task value relates to the task in that different tasks can have qualities that impact students' value in their anticipation of doing it and also in the time of their experience with it (Crippen et al., 2022). The assigned value by students to the tasks consists of four dimensions: intrinsic interest, attainment, extrinsic utility, and cost. According to Crippen et al. (2022), intrinsic interest value refers to the individuals' enjoyment or pleasure in the task given. Attainment value is the importance of completing the task well based on the extent to which a student perceives success in arranging the task in line with their self-schema.

Extrinsic utility value refers to the benefit that students acquire from the task given relative to their personal goals (both long- and short-term goals) and is the most sensitive to change.

The third aspect is self-efficacy. According to Wang (2021), there were four ways to develop students' self-efficacy: performance accomplishments such as mastering a task or situation control for having the capacity to carry out the necessary activities to succeed, vicarious experiences such as considering others as role models for elevating beliefs of sustained effort, social persuasion such as being persuaded to believe that one is capable of performing certain activities and facilitating success, and physiological and emotional states such as raising confidence for overcoming stress and low performance.

During the COVID-19 pandemic, many students had difficulty completing the tasks given because there was no one to be asked or they did not understand the material related to the assignment. Limited interaction between students and their teachers and fellow students can result in the absence of someone who can be seen and used as a role model. The COVID-19 pandemic and online learning have negatively impacted students' mental health (De Mesquita Comelli et al., 2021; Shakil et al., 2022). World Health Organization (WHO) defines mental health as a state of every individual well-being in which he realizes his potential, can deal with normal stress, can effectively and efficiently work and make a contribution to his community (Rauf et al., 2020). They also lack of support system with their peers because they can't meet with them in school.

In contrast after the COVID-19 pandemic, students can easily ask their teachers and peers if something is confusing when working on a given task, which can help students complete that task and control the situation (in this case, such as confusion or difficulty when doing assignments or understanding lessons). This is also related to the presence of someone they can use as a role model, namely teachers and peers they meet while interacting at school. During in-person learning, students also can socialize directly with their peers and get support from them. According to Bakalım and Taşdelen-Karçkay (2016), social support provided by peers can provide emotional comfort to students so that it can protect them from anxiety and stress, and help them through difficulties through guidance and feedback. It is stated that social support from peers is related to a series of positive outcomes including children's motivation, attention, academic attitudes, and achievement (Bursal, 2017).

After the COVID-19 pandemic, students feel they understand more about the material they are studying, because during this time, teachers provide more explanations, students don't feel sleepy and bored while studying, and there is easy access to ask questions if there are parts they don't understand. This has an impact on increasing students' self-confidence because they have successfully taken steps towards their success. While interacting with friends and teachers at school, they consciously or unconsciously have a support system that can increase their self-confidence in facing difficulties during learning.

The fourth aspect is self-regulation. The result showed that the mean of students' self-regulation in science teaching activities after the COVID-19 pandemic was larger. It pointed out that the students' self-regulation after the COVID-19 pandemic was higher than during the COVID-19 pandemic. After COVID-19, students have higher self-regulation ability in science teaching activities. In line with findings from a previous study conducted by Jouhari et al. (2015), this result was affected by factors consisting of family, peers, instructor characteristics, educational environment, and student (self).

During the COVID-19 pandemic, students felt helped by the assistance provided by their families, but on the other hand, students felt it was difficult to study at home because of conditions that were not conducive, such as noise caused by their families. After the COVID-19 pandemic, because students study at school, their learning process is no longer disturbed by things caused by their families at home. According to Jouhari et al. (2015), the family has a supportive and supervisory role in students' self-regulation. A supportive role of the family consists of the family environment, their support to the students emotionally and

psychologically, and things that other family members have experienced. A supervisory role of the family is to help students to be able more concentrate and focus on their studies by keeping students track of academic achievements.

During the COVID-19 pandemic, online learning made it difficult for students to meet their peers, which makes interactions between students limited, including not being able to study together or discuss with each other. After the COVID-19 pandemic, in-person learning facilitates students to be able to meet, interact, discuss, and learn together with their peers in class more freely. Peers have positive and inhibiting factors that influence students' self-regulation. Positive factors influenced by peers are students learn something from the experiences of peers and they receive motivation from their peers. Factors that inhibit students' self-regulation are a lack of motivation and success (Jouhari et al., 2015). According to Dalland and Klette (2016), students' self-regulation is affected by their learning experiences in cooperation with their peers and it is developed while they collaborate with others.

During the COVID-19 pandemic, student interaction with teachers is limited, and teacher involvement in the learning process is not as much as during in-person learning after the COVID-19 pandemic. After the COVID-19 pandemic, students and teachers can interact more freely during class and teachers are more involved in the learning process because they are no longer limited by distance and internet availability. Respondents in this study stated that teachers provided more explanations and more practical activities when in-person learning than when online learning during the COVID-19 pandemic. The role of instructors in students' self-regulation was categorized into personal and educational characteristics. Personal characteristics of instructors that can affect students' self-regulation are motivated, responsible, communication and interaction of instructor with students, the role model that students can see from instructors, and instructor seriousness during student activities. Educational characteristics of instructors consist of instructors' expertise, their lesson planning, methods for teaching, feedback to students that is timely and suitable, students' motivation, and students' engagement in class discussion (Jouhari et al., 2015).

During the COVID-19 pandemic, because students are forced to study at home, they are often disturbed by conditions in their homes such as noise caused by people in their homes. Apart from that, disruption to the internet network and devices can also hinder their learning process. Jouhari et al. (2015) stated that the educational environment can be a facilitator or inhibitor of students' self-regulation. Facilitating factors of the educational environment are students' participation in educational programs, an engaging environment and appropriate apparatus, advisers or other support services, related educational courses, and implementation of the curriculum. One of the inhibiting factors of the educational environment is the curriculum with large volume.

During the COVID-19 pandemic, students who were usually studying at school, meeting their teachers and peers, and listening to the teacher's explanations directly in class, were forced to study at home and had to face various changes that existed in online learning. Students in this study stated that the science material studied during online learning was not interesting and difficult to understand. They also stated that during online learning, they were distracted by social media and games, sleepy, not very motivated to learn, and were in conditions that were not conducive. Whereas after the COVID-19 pandemic, students stated that the science material studied was easy to understand and interesting. In previous research conducted by Jouhari et al. (2015), the personal characteristics of the student (self) can be also a facilitator or inhibitor of students' self-regulation. Personal facilitating factors such as having knowledge about self-regulation, being motivated, having high self-esteem and self-efficacy, having a successful academic record, having personal desire, positive attitude, confidence, self-encouragement, and having religious beliefs. Meanwhile, personal inhibiting factors are students' inability to implement self-regulation such as the inability to schedule their daily

activities, lack of a defined goal and concentration, and students' personal factors such as stress, hopelessness, lack of motivation, carelessness, and lack of interest in the subject studied.

The research participants answered open-ended questions about the strengths and weaknesses of science teaching activities during and after the COVID-19 pandemic. The summary of their answers can be seen in Table 4 and Table 5.

Table 4. The Strengths and Weaknesses of Science Teaching Activities During The COVID-19 Pandemic from Students' Perception

Strengths	Weaknesses
- lexible time and place - Gaining insight - Focus because students don't play around, don't talk often, and the atmosphere around is not noisy - Availability of more learning resources (e.g. internet) - Able to take advantage of technology (e.g. animated videos, pictures) that make learning more fun - Availability of more time to do the task - More flexibility; while doing other activities - Gaining a higher score - Can repeat material that has been studied (e.g. through video, slides) - Getting help from family when there are difficulties during the study - More relaxed, calm, and not in a hurry when studying; not tense - Train students' independence, courage, and creativity - Do not have to wear a uniform (except during live class via video conference) - Know and learn new technology - No need to leave early for school - It's easier for teachers to monitor students because during live class there are cameras that point directly at students - The material studied is useful in everyday life - Environmentally friendly (e.g. reduced paper use) - Try hands-on practical activities at home - Does not take as much time as in-person classes - The material provided is simple/brief - Practice making assignments - The assignments given are easy to do - It doesn't take much interaction with other people - Get more time to rest - Easier when communicating with friends - Save time and costs - Don't write too often; easy to record the lesson - Able to ask questions to the teacher without feeling embarrassed (e.g. through the chat feature on a video conference) - Maintain health	- Lack of explanation from the teacher on the material being studied - Unpleasant; uninteresting - Do not understand the material being studied; difficulty doing the task - Not meeting friends; limited interaction; cannot study with friends; no friends to discuss - Too many tasks - There are rarely practical activities - Cannot ask directly to the teacher - Constraints on the internet network and devices used for learning - Cannot see directly what is being practiced by the teacher - Unfavorable home atmosphere - Falling asleep during class - Too dependent on the Internet when doing tasks - Limited teacher supervision, so that students have the opportunity to be dishonest (e.g. looking at answers on the Internet) - Lack of study; play more often - Missed doing assignments because students were too relaxed or forgot - Distracted by social media and games - The cost required for the internet is quite large - Little motivation to study - Limited study time - Saturated learning atmosphere - The teacher's voice when explaining is sometimes not clear

Strengths	Weaknesses
- Train literacy (e.g. understanding the teacher's explanation through text) - Able to send assignments to teachers without having to meet in person	

The results indicated both science teaching activities during and after the COVID-19 pandemic have their strengths and weaknesses. However, because the results are based on students' perceptions, they tend to be subjective and one student's perception can be different from another and it may be against other perceptions. The most answers of participants about the strengths of science teaching activities during the COVID-19 pandemic are flexible time and place; gaining insight; focus because students don't play around, don't talk often, and the atmosphere around is not noisy; availability of more learning resources (e.g internet); and able to take advantage of technology (e.g. animated videos, pictures) that make learning more fun. Most participants stated that the weaknesses of science teaching activities during the COVID-19 pandemic are: a lack of explanation from the teacher on the material being studied; unpleasant, uninteresting, not understand the material being studied, difficulty doing the task; not meeting friends, limited interaction, cannot study with friends, no friends to discuss; too many tasks; there are rarely practical activities; cannot ask directly to the teacher; and constraints on the internet network and devices used for learning.

Table 5. The Strengths and Weaknesses of Science Teaching Activities after The COVID-19 Pandemic from Students' Perceptions

Strengths	Weaknesses
- The teacher's explanation is easy to understand, clearer, and more detailed - There are practical activities that can help students understand the subject matter - It's easy to ask directly to the teacher or friends when there are difficulties - Pleasant - Gain insight - It's easier when doing assignments because students already understand the material - Not too many tasks - Train students' ability to socialize - Teachers can better supervise students, making it easy to assess them - Train students in honesty and discipline - Not constrained by the internet - There is a group study system - Able to look for explanations from books in the library	- Having distractions that make it difficult to focus - Limited learning resources (e.g. no internet access, no projector to show videos/images) - Less interesting learning media used - Sleepy and boring - Availability time to do tasks is less - Too many group assignments; experiencing problems when there is a group activity (e.g. there are group members who are not active) - Lots of presentation assignments - Cannot relisten the teacher's explanation - Feeling more tired because students have to travel to school and study time is longer - There is a lot of material that must be understood in one meeting; lack of time available to understand - More material needs to be learned and the material is more difficult to understand because, during the COVID-19 pandemic, they are used to looking for answers without understanding the material provided by the teacher - Feeling nervous; lack confidence; fear of making mistakes; tense; embarrassed to ask - Missed collecting assignments due to being too relaxed or exhausted - Teachers are not friendly so they often make students feel uncomfortable - Requires transportation costs and allowance

Strengths	Weaknesses
	- The teacher rushes while teaching (because of the limited time available) without caring about students' understanding - Difficulty seeing the material in front of the class because some students sit at the back - Less orderly - There is no pause while studying - Unavailability of practical tools

Participants mostly stated the strengths of science teaching activities after the COVID-19 pandemic namely: the teacher's explanation is easy to understand, clearer, and more detailed; there are practical activities that can help students understand the subject matter; it's easy to ask directly to the teacher or friends when there are difficulties; pleasant; gain insight, and it's easier when doing assignments because students already understand the material. Most participants stated the weaknesses of science teaching activities after the COVID-19 pandemic are: having distractions that make it difficult to focus; limited learning resources; less interesting learning media used; and being sleepy and bored.

During the COVID-19 pandemic, students attended online classes which they were able to study from anywhere. Besides that, there are two learning methods: synchronous and asynchronous (Bacon & Liu, 2021). Asynchronous doesn't always require students to learn at a specific period. This method is more flexible because students can do it whenever they want. These reasons make learning during the COVID-19 pandemic have flexibility in place and time. It is also related to the flexibility of being able to do other activities during studying, not only during asynchronous learning but also during synchronous learning through video conferences. It is because there is limited teacher supervision that makes the students free to do other things without being afraid of being reprimanded by the teacher**.** This can also be a factor that constrains the learning process due to multitasking instead of focusing on one task, which in this context is learning.

Moreover, during online learning, they need devices that have a variety of functions and provide many opportunities for students to become distracted (Yeykelis, Cummings, & Reeves, 2014). This is in line with previous research showing that the use of digital devices causes significant distraction in learning (Jalil & Sabir, 2019). As stated by Rosen et al. (2013) on average adolescents and young adults switch from learning to media every 6 minutes. The phenomenon where individuals use media while engaging in other activities is referred to as media multitasking (Baumgartner & Sumter, 2017). According to Baumgartner & Sumter (2017), this phenomenon, when related to school-related activities, can cause several problems such as multitasking which can cause task performance to be disrupted, the time required to complete a task takes longer, and academic performance decreases.

In contrast with media multitasking, online learning can help students to be more focused due to the fewer distractions they get from their peers. Once students get focused, it can help them to understand the lesson**.** It is also supported by the availability of learning resources such as animated videos and pictures that can give students a visualization of what they are learning. Besides that, appropriate learning media can enhance student engagement (Zimba et al., 2020). Student engagement is the interaction between the time, effort, and other relevant factors provided by students and schools which is intended so that students can have optimal experiences, increased learning outcomes and development, as well as performance and reputation of the school (Zimba et al., 2020).

During the COVID-19 pandemic, some factors such as the availability of the internet and proper devices (Czerniewicz & Rother, 2018) and the teachers' ability to use certain technology which they had to interact with unfamiliar technology for teaching due to the COVID-19 pandemic (Adov & Mäeots, 2021), these can cause the lack of explanation that

students got from the teachers. It resulted in unpleasant feelings students experience while online learning because that forces students to learn by themselves. Besides that, the limitation of interaction among students and between teachers and students caused by they didn't going to school for a long period due to COVID-19 prevention, and the teacher's method used for teaching, can cause the students' boredom which affects the lessons were not interesting. Either the students were not interested in the lesson or the teacher did not give enough explanation to the students, it can cause the students not to understand the lesson being studied and it affects the process of doing the tasks given to them.

One of the challenges in online science teaching activities was not easy to conduct practical activities (Gasparello et al., 2022; Anderton et al., 2021) because either the tools were not available at home, the activities were not possible to do at home, or the teachers did not want to give a burden to the students by requiring them to do practical activities. Being at home during the COVID-19 pandemic affected the student's interactions with the teacher and other students were limited which resulted in they are not able to discuss with their peers and the teacher when they found difficulties while learning.

Interaction is central to the educational experience and a primary focus in research related to online learning. There are three core types of interaction: student-teacher, student-content, and student-student (Zhang et al., 2022). Interaction is a key factor in the quality of online learning where interaction is a method for students to communicate and share ideas to achieve certain goals (Wu, 2021). Timely feedback is an important component during interaction in online learning as stated by Zhang et al. (2022) that students become frustrated if they fail to receive feedback quickly. Besides that, online learning requires the internet and proper devices, which make these essential for the students and the teacher to run classes effectively (Czerniewicz & Rother, 2018). When there are constraints on those things, it could disturb the learning process.

The result in this study is in line with previous studies that pointed out the disadvantages of online learning are technical problems such as low-quality internet signal; overloaded servers and communication platforms; limited face-to-face interaction with teachers and peers; and difficulties engaging such as concentration, motivation, and isolation problem (Khan et al., 2021). The advantages of online learning during the COVID-19 pandemic are increased convenience, study schedule being more flexible, and during the COVID-19 pandemic, it was safer by avoiding contact and potential infection exposure (Razzak et al., 2022).

Science teaching activities after the COVID-19 pandemic which was held in person helped the students get clearer and more detailed explanations from the teacher. It involves some factors which were the teachers improve how they teach, there are no internet signal problems as the constraints while learning, more practical activities were able to be done in an in-person class, and students were able to directly ask for the explanation/help from the teacher or their peers when they were facing difficulties during the lesson. Once the students gain an understanding of the lesson being studied, this will not only give them some insights but will also help them in doing the assignment given.

The pleasant condition students feel while learning may be the result of the meeting of their needs that were not fully met in science teaching activities during the COVID-19, which are they can socialize with their classmates and have more interaction with the teachers which can boost their motivation to learn science. Research showed that interaction is a factor that influences students' motivation to continue learning (Liu et al., 2022). According to Alalwan (2022), interactions and communication can reinforce students' active participation which is necessary for their learning. When students can learn from their peers or teachers, it results in high levels of attention, curiosity, interest, optimism, and passion which causes the extension of their desire to learn (Alalwan, 2022). During in-person class, students were able to do practical activities that were difficult to be done by them during the COVID-19 pandemic, and they stated that their teachers' explanations were clearer.

Otherwise, after the COVID-19 pandemic, the class conditions sometimes made the students get distracted such as friends asking to talk or playing around, noisy classroom atmosphere, or students' internal factors. Students stated that they often feel bored and sleepy during learning which can be affected by some factors. Previous research showed that boredom can lead to sleepiness (Elpidorou, 2020). Students' boredom can be caused by the teaching method and media used by teachers not engaging. This is in line with a previous study conducted by Fatkhi and Sholiha (2023) which explained that if science teaching activity is teacher-centered, it can make students feel sleepy and lack focus. Another study also stated that uninteresting science teaching activity can be affected by the teacher-centered approach which is a traditional lecture (Qolbyatin et al., 2023). Besides that, related to another weakness of in-person science classes was the limited learning resources which were caused by some factors such as no internet access and the unavailability of a projector to show videos or images. This can cause the learning media used in class to be less interesting.

This study involved participants from five provinces with the highest positive trends for COVID-19. However, this research is limited to students who are predominantly in urban areas. Further research can be carried out by taking students in non-urban areas as samples to analyze the differences in results between students in urban and non-urban areas. This study showed results obtained from students' perceptions. Exploring teachers' perceptions is recommended for future research to analyze the comparison between science teaching activities during and after COVID-19 more comprehensively and the influence on students' motivation and self-regulation.

CONCLUSION

The finding of this study can be concluded that there was a significant difference in students' motivation and self-regulation in science teaching activities during and after the COVID-19 pandemic which is affected by some factors involved in online and in-person learning. The mean of all aspects which consists of students' learning goal orientation, task value, self-efficacy, and self-regulation in science teaching activities after the COVID-19 pandemic is larger than during the COVID-19 pandemic. It showed that students have higher motivation and self-regulation during in-person learning after the COVID-19 pandemic compared to online learning during the COVID-19 pandemic. Science teaching activities during the COVID-19 and after the COVID-19 pandemic have their strengths and weaknesses. Based on students' perceptions, science teaching activities during the COVID-19 pandemic is flexible, they can be more focused, and more learning resources are available. However, there are some weaknesses which are a lack of explanation and understanding, uninteresting, limited interaction, and limited practical activities. Meanwhile, in science teaching activities after the COVID-19 pandemic, they can get clearer explanations, do practical activities, and have ease of interaction. But still, it has its weaknesses which are they get distractions from peers, limited learning resources, feeling sleepy, and bored. This study was limited to the perceptions of students. It is suggested to conduct further research by considering the perceptions of science teachers to analyze the comparison between science teaching activities during and after the COVID-19 pandemic and the influence on students' motivation and self-regulation more comprehensively. The findings from this study provide an opportunity for science teachers to plan and implement effective learning strategies to increase students' motivation and self-regulation to improve their engagement and achievement in science.

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