An Exploration of FCM's Impact on Students' Perceptions of Support, Self-regulated Learning, and Critical Thinking

Nurfatimah Sugrah*, Suyanta, and Antuni Wiyarsi

***Abstract*—The flipped classroom model (FCM) has become a popular and most effective approach to implementing educational technology reforms. This study aims to 1) determine students' perceptions of support, self-regulated learning, and critical thinking skills in interventions using FCM; 2) determine the relationship between students' perceptions of support, self-regulated learning, and critical thinking skills; and 3) determine students' general perceptions of FCM learning. This type of research is quantitative with a pre-experimental design, One-Shot Case Study. The data analysis technique used is descriptive data analysis and correlation analysis. Results showed that first the quantitative descriptive results showed that students' critical thinking skills, SRL, and perceptions of support were quite good after being given the FCM intervention. Second, there is a relationship between students' perceptions of support, self-regulated learning, and critical thinking skills. The general perspective of students about FCM shows that most agree with FCM. This study shows that during FCM learning, educators can provide students with several types of support and easy access to them and ensure smooth communication. Furthermore, teachers are encouraged to take on the role of learning facilitators to strengthen students' self-regulation and thinking skills.**

***Index Terms*—Critical thinking skills, flipped classroom model, perceptions of support, self-regulated learning**

I. Introduction

Technological innovations and e-learning in education have assisted teachers and students in learning [1]. This e-learning platform has expanded boundaries in teaching and learning activities, such as coping with the limitations of time and traditional classrooms and the creation of new learning delivery methods, such as flipped classrooms, e-learning, and virtual learning [2]. The flipped classroom model (FCM) has become one of the most popular and effective approaches for carrying out the reforms needed in educational technology and has been used by several academic units [3–6]. This idea of FCM is not new but has recently become more popular due to advances in digital technology, allowing students to access resources and connections with their friends [7]. Hence, FCM has well-matchedone of the choices for teachers in learning by utilizing information technology. The conceptualization of FCM is divided into four essential elements, namely: a) time (before class, during class, after class), b) space (outside of class vs. inside class, online vs. offline); c) type of activity (individual activity vs. group activity); and d) technology use (technology-mediated vs. face-to-face interactions) [8].

FCM is a student-centered learning model consisting of two parts: interactive learning activities in the schools and computer-based learning outside of schools [5]. Bergmann and Sams [9] argue that in FCM implementation, activities that are usually carried out in the class (e.g., content presentation) become activities at home, while activities often done at home (e.g., problem-solving, discussion, and brainstorming) become activities completed at school. The basic idea of FCM is to facilitate students in reading and trying to understand the learning materials at home using an e-learning platform before they come to school [10]. In FCM, when students are in class, they can participate in activities requiring higher-order thinking which according to Bloom's Taxonomy includes applying, analyzing, or creating [11] since they have already learned the materials independently before. Likewise, more time in class can be used for problem-solving and more practical and participatory work [12]. For supporting independent learning, teachers usually design content or material in audio-visual format, for example, in the form of video [13], as these types of materials are generally included in digital platforms so that students can easily access them at any time before attending class [14]. Thus, technology-mediated practical and time-efficient learning can be possible via FCM [3]. More benefits can be gained simultaneously, i.e., developing students' higher-order thinking skills, engagement, and student satisfaction [15]. It is in line with the importance of higher-order thinking skills, including problem-solving and critical thinking, which are considered as essential as education in the 21st century [16]. In view of this, studies in developing students' critical thinking in science education have been widely reported [17].

The results of research conducted by Kurnianto and Haryani [18], for example, show that the FCM is effective in improving critical thinking skills, science learning outcomes, and student motivation. The shortcoming of FCM can be evident when students do not study autonomously before class, making it difficult for them to participate in activities such as discussion and problem-solving [2]. In FCM, however, the delivery or explanations of materials are usually given to students through videos that should be watched before class so that class time is spent on active learning activities, problem-solving, evidence-based learning, group discussions, and knowledge application, analysis, and synthesis to improve students' critical thinking skills [19]. Besides, independent learning carried out at home through videos also provides students with more opportunities to practice and interact with peers and teachers [20]. It has been

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Nurfatimah Sugrah is with Postgraduate Student Universitas Negeri Yogyakarta, Indonesia. She is also with the Department of Chemistry Education Universitas Khairun, Indonesia.

Suyanta and Antuni Wiyarsi are with Department of Chemistry Education Faculty of Mathematics and Natural Sciences Universitas Negeri Yogyakarta, Indonesia.

*Correspondence: nurfatimah.uga@gmail.com (N.S.)

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supported by several studies, reporting that FCL improves students' involvement actively in both pre-class and classroom discussions [21].

Moreover, in FCM, students can study topics at their own pace because they can pause and rewind lecture videos, search for information related to unclear and poorly understood sections, and gain the necessary basic knowledge of topics covered in class [9]. Learning with FCM is expected to encourage students to learn independently [22] and to be responsible for their learning. FCM also combines the advantages of online teaching and classroom teaching so that students acquire SRL and active learning skills [23]. FCM can increase student attractiveness, causing positive learning outcomes and self-regulated learning effects, but students' self-regulated learning abilities that are lacking can suffer losses [24]. Suppose the online learning environment does not have external support. In that case, delays may occur due to the lack of highly interactive tutoring and students relying solely on self-monitoring [25]. Thus, students should set goals for their learning and strive for self-discipline, time management, planning skills, and good self-evaluation skills [26]. It is because self-regulated learning requires active monitoring and regulation of various learning processes that involve setting learning goals, aligning learning approaches and resources, and actively responding to feedback to improve final results [27]. Later, their abilities in self-regulated learning, especially in distance interactions, can encourage them to be more involved in learning activities and produce a better learning process [26]. It possibly happens because students become more engaged in the learning process and must be more responsible for it.

One way to avoid the disadvantages of studying with FCM, such as being late for homework, is to create support for students. Help in a learning environment designed and provided according to student learning becomes central, especially in online learning [28], because the quality of student support is the main component that determines the effectiveness of online education [29]. Appropriate support strategies to meet student needs will likely enhance student learning and learning experiences. Student participation in online learning requires more support from teachers to be involved in the learning process, especially in the affective aspect [30]. Student self-control, in this context, becomes one example, and it involves individual efforts and collaboration between students and teachers [31]. A study showed significant differences in students' perceptions of online learning experiences, and it was assumed that students' perceptions of support in learning would affect their learning experiences [32].

When well-supported, active student involvement can provide an optimal learning experience. Research studies have been investigating ways to create adequate support by deeply exploring internal and external motivation. Student involvement is supported by motivation and driven by various contextual factors (teachers, peers, and environmental factors) [33]. Chiu [34] further adds that in the self-determination theory, students are motivated to grow and change by fulfilling three psychological needs, namely autonomy, the need for relatedness (feeling loved), and competence (feeling effective and capable). These three needs must be met during the learning process to increase student motivation , both in online learning and at school. The learning environment, likewise, must respond to these three needs to support student engagement in this study effectively. Three categories of support include instructional, peer support, and technical support [35]. First, instructional support refers to instructional guidance for learning which involves answering students' questions, correcting their misunderstandings, providing clear instructions, relevant resources, and constructive feedback on their assignments and performance. Secondly, peer support refers to peer-to-peer learning involving students supporting each other on academic or non-academic issues. Lastly, technical support includes assisting with any technical issues students may encounter in the online learning process and at school.

While previous studies on FCM have already investigated the ideal learning stages, support, outcomes, learners' engagement, and possible shortcomings, none focused on exploring the factors that influence critical thinking related to student support and self-regulated learning. Primarily, research on science learning in junior high school (JHS) and applying the FCM is still limited. However, it is deemed essential because it serves as input for teachers to determine the types of support and forms of self-regulated learning that students need when implementing FCM. This is relevant especially for JHS students who are still in the development stage and likely require more help and assistance to study effectively.

A. *Purposes of the Study*

As reported, learning in FCM at the junior secondary level requires teachers, peers, and environmental and technical support [33]. Students' perceptions of the support they receive can vary depending on many factors, including learning format, structure, communication tools, number of students, teacher teaching style, and student learning style [35]. On the other hand, the satisfaction of learning in FCM may depend on the full support of the students themselves.

In FCM learning, video as a learning format gives students control, for example, when to watch and pause it [36]. Therefore, students at FCM need to organize themselves to achieve the desired learning goals. This study therefore, aims to reveal students' perceptions of support, self-regulated learning, and critical thinking skills, the relationship between students' perceptions of support, SRL, and critical thinking skills, and the general perceptions of FCM by answering the following questions that guide the research:

- At what level are students' critical thinking skills in learning using FCM?
- At what level are students' perceptions of support for learning using FCM?
- At what level are students' self-regulated learning in learning using FCM?
- What is the relationship between students' perceptions of support, SRL, and critical thinking skills in FCM learning?
- What are the junior high school students' views on FCM?

II. Materials and Methods

A. Design

This is a quantitative research with a pre-experimental one-shot case study design. Instruments for assessing students' perceptions of support, self-regulated learning, and students' critical thinking skills were distributed after being treated with FCM intervention. This study only used the experimental group without any pretest or comparison group. The one-shot case study research design is explained as follows [37].

X	O

Information:
X = treatment given (independent variable)
O = observation (dependent variable)

B. Participants

Selected by convenience sampling, the respondents in this study consisted of 69 8th-grade students of one junior high school in Klaten Regency, Central Java, Indonesia, for the 2021–2022 academic year. All participants were students who took the science subject whose learning is in FCM. For the present study, the topic being studied were additives and addictive substances.

C. Instruments

The instruments used in this research are as follows:

1) Critical thinking skills test

The critical thinking skills test (CTST) collected data on students' critical thinking about additives and addictive substances. Aspects and indicators of CSTS have been synthesized from Ennis [38], Facione [39], and the Watson-Glaser Critical Thinking Appraisal (WGCTA) [40]. It consists of six aspects and is translated into 6 indicators as seen in Table I.

The six indicators synthesized above developed ten items in the CTST into essay questions. Before the instrument was used, it went through a set of validation stages with the Focus Group Discussion (FGD) technique and construct validation using the Rusch model. Five expert lecturers conducted content validation by assessing the accuracy of the synthesis of aspects and indicators, the suitability of the questions and answer keys and the accuracy of grammar in the questions. Based on expert input, revisions were made, and further empirical tests were carried out. The empirical test was carried out by involving 9th-grade students of one JHS with 71 students participating. The Rasch model later analyzed the test results to determine the quality of the item fit with the model or item fit. The results indicated that all these ten CTST questions are valid. For the reliability analysis, Cronbach's alpha value was employed, namely the interaction between the person and the items as a whole contained in the Rasch model analysis. The reliability results show the Rasch model input with a value of 0.77, so it can be concluded that the CTST is reliable.

TABLE I: INDICATORS OF CRITICAL THINKING SKILLS

No	Aspect	Indicator
1.	Introduction of assumptions	a. Identifying assumptions. b. Assessment of assumptions.
2.	Providing a basic explanation	a. Focusing the question. b. Analyzing arguments.
3.	Interpretation	a. Categorizing. b. Clarifying the meaning.
4.	Analysis	a. Testing ideas. b. Identifying arguments. c. Identifying reasons and questions.
5.	Evaluation	a. Assessing the credibility of the question. b. Assessing the quality of arguments made with inductive or deductive reasoning.
.	Summing up	a. Deducing and considering deductions. b. Inducing and considering the results of induction. c. Creating and assessing the values of the results of consideration.

2) Perceptions-of-support questionnaire

The questionnaire on support perception used in this study was adapted from Lee *et al*. [28]. It includes 20 items about support on a 5-point Likert scale (from 1-strongly disagree to 5-strongly agree). Although the instrument was deemed valid and reliable due to the different characteristics of students, construct validity has been carried out. This questionnaire was tested on 64 students in grade 9. Item analysis of the test results was also carried out using the Rasch model to determine the validity and reliability of the instrument. The indicators of support are shown in Table II.

TABLE II: QUESTIONNAIRE OF STUDENTS' PERCEPTIONS OF SUPPORT

Category	Indicator	Number of Items
Learning support	a. The teacher gives clear instructions for assignments and quizzes. b. Feedback on my assignments is constructive. c. I feel that I can ask the teacher questions about the learning material. d. I feel that teacher is easy to contact. e. The teacher responds to student questions promptly.	6
Peer support	a. There are many opportunities to interact with peers. b. I hesitate to ask for help from other students. c. Students who take this subject are willing to assist other students.	4
Technical support	a. Asking for technical assistance is difficult for me. b. I know where to ask for help if I have a technical problem. c. Technical support responds to my problems promptly.	5

The number of items before the testing was 19 items. After the testing and calculating of their validity with the Rasch model, it was found that four items were invalid, so the questionnaire of support perception used in the study comprises 15 valid items. For item reliability, Cronbach's alpha value was also employed in the results of the Rasch Model analysis, and it was found that its reliability value is 0.89.

3) Self-regulated learning scale (SRL)

The self-regulated learning questionnaire utilized in this research was adopted from Barnard *et al*. [41]. This questionnaire consists of 24 items with a 5-point Likert response format and a score response format ranging from strongly agree (5) to strongly disagree (1) for a positive statement, and vice versa if the statement is negative. It covers six indicators, namely environment management, goal setting, time management, task strategy, help-seeking, and self-evaluation, as seen in Table III. Although this questionnaire was valid and reliable according to Barnard *et al*. [41], as with other instruments construct validity was carried out. The item analysis of the test results also harnessed the Rasch model to determine the validity and reliability of the instrument. The results of the validation for the SRL category of the 24 tested items show that one item is not valid based on the item analysis, while its overall reliability value is 0.76.

TABLE III: INDICATORS OF SRL

Aspect	Indicator
Goal setting	a. Setting standards in learning. b. Setting learning goals.
Environment management	a. Choosing a convenient location for studying. b. Choosing a comfortable atmosphere for learning. c. Choosing a convenient time to study
Task strategy	a. Making notes. b. Reading learning materials. c. Preparing questions. d. Looking for literature related to the material. e. Allocating time for extra study.
Time management	a. Setting a schedule to study.
Help-seeking	a. Consulting with more capable friends b. Seeking help from the teacher
Self-evaluation	a. Summarizing learning b. Asking the teacher c. Communicating with friends to increase knowledge

4) General perspectives about FCM

For the investigation of students' perspectives on FCM, a questionnaire wes distributed to students using a scale of strongly agree (4) to strongly disagree (1). There were three questions covered each of which asks about 1) a good learning experience, 2) meeting my learning needs, and 3) agreeing with the idea of a flipping program.

III. DATA COLLECTION AND ANALYSIS

Data were collected after students carried out science learning using FCM. The data collection was carried out during the pandemic with a limited face-to-face system. Learning before class at home was done by watching videos containing science material using the Moodle learning platform . Then, students were given problems related to learning materials to discuss in class. The learning process was carried out for three weeks. After the learning process, students were required to take the critical thinking skills test (CTST), a questionnaire about the perception of support, and the self-regulated learning questionnaire. Both the test and questionnaires were administered directly in class in print for students to work on.

The results of the tests and questionnaires were then analyzed by using SPSS 23. Descriptive statistics were used to report the categories of students' perceptions of support, self-regulated learning, and critical thinking skills. The data analysis steps were calculating the average score, both the total and the score on each measurement indicator, and then categorizing the measurement results. According to Azwar [41], the determination of each indicator's category should be based on the standard deviation value and the ideal maximum/minimum score. Students' perceptions of support, self-regulated learning, and students' critical thinking skills were categorized as very good (>97.6); good (84.8-97.5); fair (59.2-84.7); poor (43.2-59.1), and very poor (<43.2). Correlation analysis was employed to examine the relationship between perceptions of support, self-regulated learning, and students' critical thinking skills. Descriptive statistics were also used to determine students' general perceptions about learning FCM.

IV. RESULTS

A. Categories Students' Perceptions of Support, Self-regulated Learning, and Critical Thinking Skills

The results of the descriptive statistics for support, self-regulation, and critical thinking skills are shown in Table IV.

TABLE IV: RESULTS OF THE DESCRIPTIVE STATISTICS FOR EACH CATEGORY

Descriptive Statistics	N	Min	Max	Mean	SD
Support (X1)	69	64	99	80.25	8.839
Self-regulation (X2)	69	62	91	75.83	8.129
Critical thinking (Y)	69	34	86	66.70	12.681

The results of the descriptive analysis show that the average value for critical thinking skills is 66.70, which is in a quite good category. About 5.79% of students are in a good category; 65.21% are in a good category, 27.54% in the fair category, and 1.15% in the poor category. The highest percentage is on the analysis indicator, with a mean of 89.86%, and the lowest percentage is on the interpretation indicator, with a mean of 57.65%. The description of each indicator is presented in Fig. 1 below.

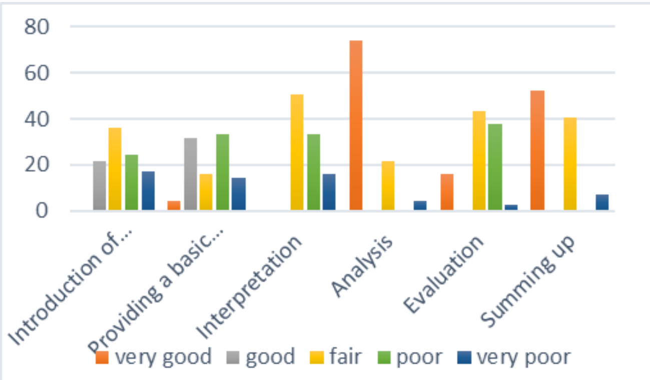

Fig. 1. Category of students' critical thinking skills in each indicator.

The results of the descriptive analysis of self-regulated learning are in the fair category with a mean average of 75.83, with the distribution of categories as follows. There are about 5.79% in the good category, 65.21% in the fair category, 27.53% in the poor category, and 1.45% in the very poor category. The highest percentage is on the environmental management aspect, with 82.0%, and the lowest rate is on the help-seeking aspect, with a mean of 63.7%. The description of each indicator is presented in Fig. 2 below.

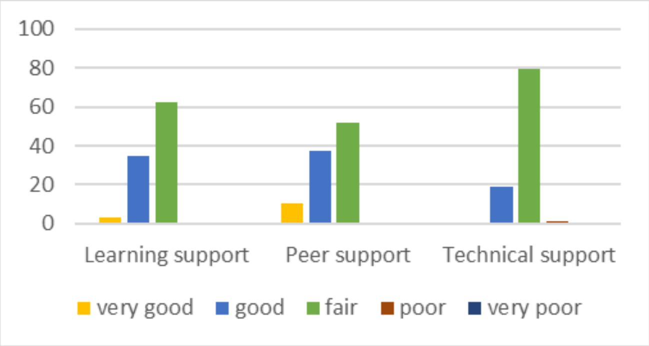

Fig. 2. Category of students' self-regulated learning in each indicator.

The results of the descriptive analysis of students' perceptions of support were in the fair category, with an average of 80.25, with the distribution of categories as follows. There are about 2.89% in the very good category, 36.23% in the good category, and 60.87% in the fair category. The highest percentage is in the learning support aspect, with 82.11%, and the lowest is in the technical support aspect, with an average of 76%. The description of each indicator is presented in Fig. 3 below.

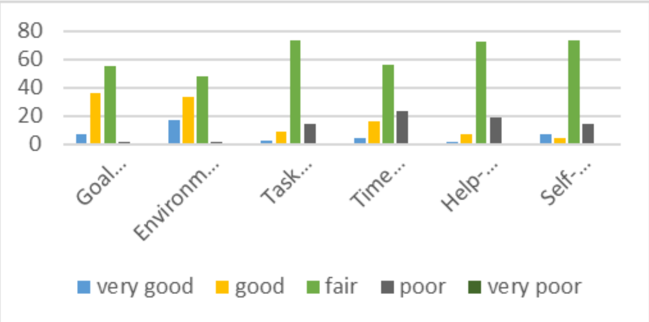

Fig. 3. Category of students' perceptions of support in each indicator.

B. The Relationship between Students' Perceptions of Support, SRL, and Critical Thinking Skills

The relationship between students' perceptions of support, SRL, and critical thinking skills is presented in Table V below.

The results of the correlation analysis showed a sig value of 0.000 ≤ 0.005 for all relationships variabls, so it can be concluded that there is a relationship between students' perceptions of support, SRL, and critical thinking skills using FCM.

TABLE V: CORRELATION ANALYSIS RESULTS

		Support (X1)	SRL (X2)	Critical thinking (Y)
Support (X1)	Pearson Correlation	1	0.449**	0.439**
	Sig. (2-tailed)		0.000	0.000
	N	69	69	69
Self-regulation (X2)	Pearson Correlation	0.449**	1	0.486**
	Sig. (2-tailed)	0.000		0.000
	N	69	69	69
Critical thinking (Y)	Pearson Correlation	0.439**	0.486**	1
	Sig. (2-tailed)	0.000	0.000	
	N	69	69	69

C. Students' General Perceptions of FCM

Three survey questions were used to determine students' general perceptions of learning using FCM (Table VI). The study reveals that 97% of students either strongly agree or agree that FCM is a good learning experience, and only 3% disagree that FCM does not provide a good learning experience. Almost all 96% respondents also strongly agree or agree that FCM meets their learning needs, and the remaining 4% disagree. Lastly, 96% of the surveyed students strongly agree or agree with FCM learning, and the remaining 4% disagree with FCM.

TABLE VI: GENERAL PERSPECTIVE ON FCM THROUGH SURVEY ITEMS

Items	Strongly agree	Agree	Dis agree	Strongly Disagree	Mean	SD
a. Good learning experience,	52%	45%	3%	0%	3.41	0.55
b. Meets my learning needs.	32%	64%	4%	0%	3.28	0.54
c. Agree with the idea of flipped courses.	32%	64%	4%	0%	3.28	0.54

V. DISCUSSIONS

Quantitative descriptive and regression analyses were examined to provide a complete picture of learning using FCM at JSC. The former analysis results show that critical thinking skills are in the fair category after intervention with FCM. Likewise, students' perceptions of support and SRL are all in the fair category. This study likely found that the results on critical thinking skills through intervention with FCM are fair. The category is in the fair because it is alleged that the learning meeting only takes three weeks of the learning process so that the critical thinking development is not optimal. However, there are still indicators of critical thinking skills that is in the good category, namely analyzing. This is in accordance with the research conducted by Kurnianto *et al*. [18] that FCM is effectively used to improve critical thinking skills. In addition, another study has also revealed that FCM has a positive effect on the development of student's critical thinking skills, and it is more effective than traditional classrooms [42]. FCM generally begins with an online intervention explaining the material given to students in a video and to watch before class, then continued at school with more time to synthesize concepts and solve problems given by the teacher [43]. Such activities can improve critical thinking skills [19]. In addition, grouping students in this intervention can foster teamwork and relationships between them. Collaborative activities and teamwork improve critical thinking because they allow students to share ideas with others and provide feedback. Thus, students will better understand the topic through this activity [44].

It is also found in this study that the analysis aspect is the only indicator with the highest percentage in the good category. Meanwhile, other aspects, namely providing a basic explanation, introductions of assumptions, and summing up are in the fair category. The interpretation aspect is in the poor category, and this aspect has the lowest percentage. In the interpretation aspect, students were asked to interpret the situation as a whole and justify it by drawing specific results based on the facts coming to their mind. In this section, students still find it quite challenging to interpret the problem and provide justification with a theoretical view. Students still tend to narrowly interpret the problems given without being supported by solid evidence and theoretical views. Considering this, interpretation skills are essential in critical thinking [45]. On the other hand, the results of SRL with FCM intervention are the fair category. It is in line with Chang's *et al*. [46] that using self-regulated flipped classrooms significantly increases self-regulation. Fitriyana *et al*. [47] likewise show that hybrid learning with video conferencing significantly affects SRL. The high percentage of self-regulated learning is apperent on the environment management indicator and the lowest ison the indicator of help-seeking. The results of other relevant study show that high SRL is mostly achieved through environment management [48].

The environment management in the intervention using FCM is more directed at learning before class. Here, there is no direct supervision from the teacher. The critical role depends solely on the students themselves. Students have built a comfortable atmosphere and chosen an appropriate time for online learning because they are used to online learning during the pandemic. Besides, the lowest indicator is in the aspect of help-seeking assistance probably because this learning is still in the pandemic situation in which, assistance from teachers and colleagues is still minimal. Help, however, is essential to support student self-regulated learning. As a solution, one way to get students enthusiastic about watching videos from home is to use self-regulation support [49].

According to Sun *et al*. [25], high SRL students can easily deal with learning problems and adapt to different learning contexts. This kind of process can help them to think critically. Thist is in line with Kondakçi and Aydin [50], suggesting that SRL plays a key role in critical thinking. Phan [51] also agrees that developing SRL skills can increase critical thinking. It means that critical thinking has a positive influence on students' SRL. The more students develop their critical thinking skills, the more SRL their learning process will be. Thus, the theoretical orientation of self-regulation and critical thinking are interrelated. In other words, the process of self-regulation can foster a critical attitude [52]. The results of Wong *et al*. [36] similarly indicate that engaging learners in strategies related to SRL, such as goal setting, strategic planning, time management, and effort management, can influence their success in an online learning environment. When using FCM, students become more independent, meaning that they also need self-monitoring and regulation. However, students are not allowed to take complete control of their learning. For strengthening students' SRL, teachers are therefore advised to take on the role of facilitator of learning or support. Students are also encouraged to monitor and manage their study time and interactions with their study partners so that more independent students will become more effective learners and higher achievers [27].

The students' perceptions of support also showed a fair category. The highest percentage is on the learning support, and the lowest is on technical support. Learning support in the intervention with FCM is included in the provision of learning videos before class. Through the e-learning platform and provided learning videos, students can also ask questions on the platform. In the technical support aspect getting a low percentage, the data ware taken during the covid 19 pandemic where, there is limited space between students, teachers, and their peers directly solve technical obstacles. Besides, learning during the pandemic continues to apply physical distancing, so students and teachers limit their interactions in the classroom, leaving the support provided is not optimal.

Moreover, it is applied to JHS students who might depend primarily on support to learn effectively, but their characteristics differ. As the same type of support may have relatively different effects, the teacher's roles should include providing various kinds of support for students to choose the type that suits their learning style. Providing teacher and peer support to students significantly influences student success [53], saying that interactions with teachers and peers play a central role in supporting young adolescents' academic motivation. According to Huang *et al*. [54], support from teachers and peers is an essential component that can affect student academic achievement. When students feel their teachers emotionally support them, they tend to be more actively involved and make a more significant effort or are more motivated in their learning. Students can receive support from their classmates through friendship and in a way that facilitates learning. Peer support has greater reciprocity because peers share the same status [55]. In addition to teacher and peer support, students must be provided with technical support in this FCM because these problems can create challenges and determine student satisfaction in an online learning environment [56]. Students who use online learning technology without barriers will surely be comfortable in learning, so that it can affect learning outcomes.

In addition to providing various types of support for students, the most important thing is how students have easy access to the support provided. However, the challenge would be whether they know how to utilize the support when encountering problems. Therefore, from the start of learning in both online and conventional classes, the teacher should convey to students the support provided during the learning process. As with online learning that uses technology in learning, it is unavoidable that students will experience technical problems. Technical obstacles faced by students certainly need support from teachers and peers.

Another important aspect of student support is communication. Communication has been equally important to respond to problems faced by students quickly. The teacher's direct response to students' questions and problems can affect student learning outcomes and satisfaction [29]. More frequent interactions with teachers and higher quality interactions will allow students to complete their learning [57]. Support can also be a separate satisfaction for students in learning, which is in line with the findings in this study that there is a relationship between perceived support and learning satisfaction.

The correlation analysis results, as the second type of analysis, uncover a relationship between students' perceptions of support, SRL, and critical thinking skills in learning using FCM. This study's results likely align with the research conducted by Jung *et al*. [49], that students with regulatory support gained a better conceptual understanding and engaged in highly collaborative processes. Support for SRL in FCM learning demonstrates higher SRL skills and involvement in pre-class and in-class sessions [58]. High conceptual understanding and actively participating in the learning process will train students' critical thinking. In the FCM class, students must be able to manage to learn, especially in pre-class activities that are not monitored directly by the teacher. Students usually need help from teachers or colleagues to strengthen student's their SRL. Integrating appropriate learning strategies into FCM learning is the key to intensifying students' higher-order thinking, including critical thinking [59]. However, to enable learners to interact effectively, it is essential to provide the necessary guidance [16]. Hence, guidance, SRL, and critical thinking in FCM are closely related.

Morever, the results of students' general perception of FCM learning show that most students think FCM provides a good learning experience, claim that FCM meets student learning needs and agrees with FCM. This conforms Forsey *et al*. [60] findings that students could benefit from learning by using a flipped classroom. In addition, it is also in line with research conducted by Hao [6] that students gain a good experience and agree with FCM. Positive perceptions of FCM students can also emerge because sampling was carried out during a pandemic where learning for approximately three semesters was carried out by distance learning or entirely online. When students face mixed learning, they immediately respond positively because of face-to-face meetings. However, although students respond positively to FCM, theymust control themselves or take responsibility for their learning; this is where student SRL is needed. Students should strive for discipline, time management, and evaluation of their learning. According to Boelens *et al*. [61], self-learning is critical to all technology-mediated learning, particularly the success of FCM. In addition to the importance of SRL in FCM learning, support for students is also essential as reported in the discussion above.

VI. Conclusions

The quantitative descriptive results show that critical thinking skills, SRL, and students' perception of support after intervention with FCM are the fair category. The correlation results show a relationship between students' perceptions of support, SRL, and critical thinking skills. Students' perceptions of FCM are likely positive concerning its contribution to learning experiences and learning needs, and that most learners agree with FCM.

Although FCM is a student-centered learning model, the role of the teacher is also crucial in this learning. Among them are in providing several types of support. Students can choose what type of support that fits their characteristics, how students have easy access to the support provided, and how communication with students promote their learning. In addition, by using FCM, students become independent learners in that they need self-regulation, but are not allowed to take control of their learning fully. Therefore, to strengthen students' self-regulation, teachers are advised to take on the role of facilitator of learning and provide some support to students.

This study probably provides insight into how students' goal setting, strategic planning, and time management are essential in FCM learning. In addition, students with a high SRL are easier to deal with problems in learning and quickly adapt to different learning contexts, thus triggering students' critical thinking. In this study, should students get support from teachers and peers, they are emotionally inclined to engage more actively and be more motivated in their learning. The support provided will also foster feedback between students and teachers and vice versa. The types of support expected are support in learning (including support from teachers), peer support, and technical support.

Finally, although the results obtained in the study seemvery satisfactory, the sample selected was probably negligible. However, the employed method can justify this study. In addition, the results of this study are supported by the high reliability of the research scale used. This research can also a good starting point as a reference for junior high school teachers when applying FCM in learning in the hope of discovering new findings and as an additional validation process that can contribute to generalizing the results obtained.

Conflict of Interest

The authors declare no conflict of interest.

Author Contributions

Nurfatimah Sugrah conducted research, analyzed data, and wrote the paper. Prof. Suyanta supervised and provided suggestions and guidance during the research. Dr. Antuni Wiyarsi provided suggestions and guidance during the implementation of the research, providing input on the paper's contents.

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Nurfatimah Sugrah is a lecturer in chemistry education at Khairun University, North Maluku Province, Indonesia. Now she is a doctoral student at Yogyakarta State University in the study program of education science. His current research interest is the use of the inverted classroom model in science learning.

Suyanta Suyanta is a chemistry lecturer at the Faculty of Mathematics and Natural Sciences at the State University of Yogyakarta. He is a professor in analytical chemistry. Although he is a professor in analytical chemistry, he pursues several research fields in education such as teacher professional development. His current research interest in education is in virtual laboratories.

Antuni Wiyarsi is Associate Professor of Chemistry Education at the Faculty of Mathematics and Natural Science, Universitas Negeri Yogyakarta, Indonesia. Her research interest is in context-based learning, Socio-scientific issue, scientific habits of mind, transferable skills, chemical literacy, pedagogical content knowledge, science teacher education, and STEM learning. Her recent publications in reputable journal are A SYSTEMATIC REVIEW OF THE RESEARCH PAPERS ON CHEMISTRY-FOCUSED SOCIO- SCIENTIFIC ISSUES' and 'Promoting Students' Scientific Habits of Mind and Chemical Literacy Using the Context of Socio-Scientific Issues on the Inquiry Learning'.