Flipped classroom analysis in science online learning based on literature review in improving to improve collaborative problem solving (CPS)

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	Abstract
Keywords: Collaborative problem solving; Flipped classroom; Online learning;	This study aims to analyze flipped classrooms in online learning in improving to improve Collaborative Problem Solving (CPS) skills. The application of the Flipped Classroom strategy can provide a number of advantages for teachers and students. Where it is very helpful in online learning. CPS skills include 21st century skills that are influential in the field of life. CPS is complex in nature involving cognitive and social abilities. The benefits expected from this research are to become an alternative teaching and learning activity during online learning. This research method is a literature review through a literature study with a qualitative approach. The data obtained is identified and analyzed to become a meaningful knowledge. The results of the study show that the role of technology in flipped classroom learning provides an overview of the quality of learning using technology. Flipped classrooms provide opportunities for collaboration and interaction that are beneficial in mastering collaborative problem solving skills. The conclusion in this study is that flipped classrooms in online learning can improve students' collaborative problem solving skills.

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Introduction

Development of technology and science in the 21st century has an impact on various fields of life. These developments require mastery of 21st century skills including Collaborative Problem Solving skills. The survey results of the National Association of Colleges state that collaboration skills are in the top position and are needed for human progress (Banar, 2015). This skill is complex which are individuals with good mastery of collaborative problem solving are very useful in the world of work and society (Rahmatih et al., 2020). Solving ability problems and the ability to make decisions is is very important to make decisions in solving problems in new situations (Haryadi & Pujiastuti, 2023).

Collaborative Problem Solving skills have a goal of preparing students to live in society. The learning process that emphasizes Collaborative problem solving makes students accustomed to working together in solving problems by combining various initial knowledge of each individual so that they can construct more complex knowledge (Hannania et al., 2022). The process of collaborative problem solving carried out by students can also bring about an affective attitude in the form of the ability to communicate, evaluate and self-

regulate so that it can lead to making the right decisions (Sukmawati & Permadani, 2021) . During collaborative problem solving, students also ask other groups for help when they have difficulties. Interaction within and across groups gives students the opportunity to overcome obstacles and continue discussing their solutions without having to wait to receive help from the teacher, so that students are invited to find solutions independently (Karabulut-ilgu et al., 2017).

Collaborative Problem Solving will train critical skills to plan, analyze, and evaluate student group work. Each individual must have collaborative problem solving skills that are adaptive and can be generalized into tasks and the community environment (Graesser et al., 2018) . Collaborative problem solving skills that are integrated in schools help students explore problem solving, decision making, and critical thinking (Andrews-todd & Kerr, 2019) . Collaborative problem solving activities are very closely related to social and constructive nature, so they are often referred to as an integral instructional approach (Chang et al., 2017) . These skills facilitate the construction of science knowledge.

Education is an effort that is carried out consciously and planned with the aim of providing a pleasant learning process and atmosphere so that students can absorb the subject matter easily. Science education is a very important education. Ironically, Indonesia is ranked low, namely 74 out of 79 countries with a science score of 371. This shows that science skills in Indonesia are still relatively low, so that relevant and appropriate learning is needed, following the results of Indonesia's PISA ranking released by the OECD in 2019. The current condition of learning can be done online and offline. Online learning is learning activities that use the internet and digital tools. Online learning is a form of delivery of conventional learning that is poured in digital format via the internet. Online learning has its own strengths, challenges, and obstacles. In addition, online learning places more emphasis on the thoroughness of students in receiving and processing information presented online.

Flipped classroom is one of the pedagogical approaches, whose activities are structured more effectively in providing education with more face-to-face interactions with students and can increase the flexibility of the learning schedule to improve learning outcomes (Ahmed & Indurkhya, 2020), can increase students' self-efficacy, and students can organize themselves well so that performance increases (Lai & Hwang, 2016). The key premise of the Flipped Classroom strategy is that students engage with important content before attending class, while opportunities for higher-order thinking are provided during class time (O'Flaherty & Phillips, 2015). Based on the case, flipped Classroom strategy as an interactive group learning activity in the classroom, and directs individual computer-based instruction.

Flipped Classroom strategy can provide a number of advantages for teachers and students. For example, using active learning strategies in the classroom allows teachers to better understand students' learning styles and difficulties; to use class time more effectively and creatively; and to meet the learning needs of diverse student groups according to the curriculum and provide personalized teacher-to-student guidance and peer-to-peer collaboration (Roehl et al., 2013). The advantage of the flipped classroom is that students can be responsible for their learning by controlling the pace of learning, mastering teaching materials, and being prepared when in class (Long et al., 2017).

Based on the background that has been described, the researcher wants to discuss more deeply about the implementation of flipped classroom on collaborative problem solving abilities. The purpose of this study is to analyze the implementation of flipped classrooms in online learning in improving collaborative problem solving abilities.

Method

The method used by the author is a literature review or it can be called a literature review. Literature review is a description related to references that are relevant to a particular topic. Literature review according to Mazid (2017) is a result of examining the findings of data in the form of literature and literature. Data collection is done by finding sources and constructing from various sources such as journals, books, and research that has been done. The library material that has been obtained is then critically and in-depth analyzed with the aim of being able to support the propositions and ideas (Adlini et al., 2022) .

The data sources for this research are scientific articles published in national and international journals in the last 10 years (2012-2022) with a total of 41 articles. The object of this research was explored through various kinds of library information in the form of national and international scientific articles from 2012-2022. The process of searching for literature that is relevant to the purpose of this study was carried out in 3 journal databases, namely Sciencedirect, Scopus, and Publish or Perish. The keywords used in searching for relevant titles and abstracts were " flipped classroom ", " collaborative problem solving ", and " flipped classroom and collaborative problem solving ".

The stages carried out by the author in compiling this literature review are (1) determining the topics used in the writing material, (2) sorting and selecting supporting theories or reviews related to the topics raised from various books and research articles, (3) identifying and processing the theories that have been obtained, (4) combining them into a synchronous and coherent part, and (5) expressing ideas and ideas from the literature review that has been put forward (Hartini, 2017). The process carried out for the selection of literature must be in accordance with the inclusion and exclusion criteria. The following are the criteria for selecting the literature in this study.

Table 1. Inclusion and Exclusion Criteria

Inclusion Criteria	Exclusion Criteria
a. The object of research is a student or students	a. Research in the form of scientific articles, theses, final assignments, theses, and dissertations
b. Research describes or describes flipped classrooms, collaborative problem solving, or both	
c. Research using Indonesian or International	b. Research does not explain the failure factors in a structured or dimensional way

The approach used by the author is a qualitative approach, which is a research conducted by investigating a humanitarian or social problem based on a methodological tradition (Damanhuri et al., 2016). Then processed by the author into general statements with his own language style. The main ideas outlined are briefly, objectively, critically disassembled and searched for links or connections with previous theories that have been worked on and put forward by previous researchers (Karuru, 2013).

Results and Discussion

Online learning is a learning activity by utilizing the internet network, local area network as a method of interacting in learning such as delivering material with computer, laptop or smartphone facilities connected to an internet connection (Ramopoly & Baka, 2021). Online learning contains various aspects, namely media as a learning communication tool that is used as an option for the learning process, lecturer readiness in the process of delivering material, evaluating student learning processes with various forms of assignments and tests given, as well as student independence in exploring knowledge and honing abilities (Andiarna & Kusumawati, 2020).

Such learning has been adapted in the post-pandemic era as it is today, various models and approaches can be implemented and adapted according to learning needs. Online learning needs to be developed in accordance with current developments in communication technology. Technology has not only changed lifestyles and ways of communicating, but also changed the way we learn (Stoytcheva, 2018). Online learning generally utilizes internet services through certain platforms, one of which is the flipped classroom. Learning using a flipped classroom is suitable for application to online learning where the teacher prepares learning materials in the form of learning videos for students to study at home. Students can repeatedly view and study material in learning videos (Sappaile et al., 2020). Agree with this, the flipped learning model is good for use during online learning (Sari et al., 2021).

Flipped classroom as a strategy that is given by minimizing direct instruction during learning activities and is carried out by maximizing interaction between educators and students (Johnson, 2013). Flipped classroom there are advantages, namely: 1) practicing student learning independence by providing some material as study material at home before class meetings; 2) One strategy that can be applied in increasing interest in learning and the quality of the learning process. The flipped classroom strategy is a combination of learning activities carried out in the classroom and outside the classroom so that students can still access, view, and learn material from the teacher repeatedly with the internet network or videos provided during learning (Syam, 2014).

Teacher activities in the flipped classroom consist of: 1) preparing students and parents; 2) preparing learning materials; 3) delivery of learning concepts; 4) monitoring; 5) elaboration and exploration; and 6) evaluation (Yanuarto et al., 2021). For an explanation of the stages of activities in the flipped classroom presented in table 2. below.

Table 2. Flipped Classroom Learning Stages

No.	Stages	Explanation
1.	Prepare students and parents	According to (Hidayah & Mustadi, 2021) while studying at home, students are required to study the concept material provided by the teacher. This process relates to the preparation of students before learning at school. Students are encouraged to prepare very well while at home. Student-centered learning activities make students fully responsible for the material to be studied and require them to develop metacognitive skills in order to be successful in their learning. Meanwhile, during class activities, students actively participate during presentations and discussions (Wei et al., 2020).

		Lestari & Noer (2021) flipped classroom provides an opportunity for parents to have quality time with their children. In line with Katsa et al. (2016), flipped classrooms in the technological era provide opportunities for parents and students to collaborate in educating and teaching at home.
2.	Prepare study material	The teacher prepares the material before class activities. This material has special characteristics in a flipped classroom (Ramakrishnan & Priya, 2016). These characteristics are easy to access using technology, easy to learn, and practical to use. Apart from that, material is also illustrated in various ways, such as viewing media on YouTube or using certain projects (Efiuvwere & Fomsi, 2019), many methods are used to structure concepts, such as learning videos (Rafiepour, 2020), virtual teaching (Deliktaş & Stojkovska, 2019), educational games (Novitasari et al., 2020), project learning (Pardimin, Rochmiyati et al., 2020), and collaborative activities (Cramer, 2020).
3.	Setting up the learning concept	The process of sharing learning concepts used in teacher modules, notes, or textbooks (Rafiepour, 2020). Flipped classroom learning gives teachers plenty of time to prepare student modules before class activities — offering notebooks to students to study (Weingart, 2019).
4.	Monitor students a	According to Wei et al. (2020) there are three ways that teachers can do the monitoring process. First, ask students to make a summary. Providing summaries can help teachers understand students' thinking during class activities. In addition, the summary process gives an impression of the quality of student learning independence (Cramer, 2020). Second, the parent team works in the flipped classroom. Collaboration between parents and teachers in monitoring has an effective technique for student success (Fung et al., 2021). In line with Lestari and Noer (2020), parents and teachers are two important figures in creating quality flipped classroom learning. Finally, give students project assignments. This can help teachers guide students' abilities and understand the material (Pardimin, et al., 2020).
5.	Elaboration and exploration	Elaboration and exploration are carried out during situations in the classroom. Based on Makinde (2020), during classroom learning, elaboration and exploration can run classes effectively and efficiently. Purba et al. (2021), explained that there are five procedures that teachers can carry out during the process of elaborating and exploring concepts in a flipped classroom: 1) discussing concepts coherently and starting concepts for the next lesson; 2) expand the concept with maximum reading and explanation; 3) the teacher answers and responds to student questions; 4) the teacher gives projects to students to work on as an effort to see students' mastery of concepts, and 5) reviewing concepts that have been discussed in more detail
6.	Evaluate	Evaluation is an important activity in a flipped classroom (Birdsall, 2017). Evaluation activities can be carried out in several sessions or at the end of the learning session. Evaluation does not only provide a test of the implementation of learning, but also contains the results of reflection from students and parents.

Flipped classroom implementation in class is related to project discussion activities both between team members, between teams, and with educators. Before learning in class begins, students can study at home with books and videos related to material from the teacher, where learning material has been integrated with the culture in society. Then learning in the classroom that involves students in collaborative and hands-on activities which is very

supportive in solving the problems represented in a project. Flipped classroom can provide opportunities for students to practice collaborative problem solving.

Flipped classroom is a teaching method that "reverses" traditional teaching methods, in this method instructions are delivered outside the classroom, while class time is only devoted to problem solving. The role of the teacher here as a facilitator in learning (Bergmann & Sams, 2012)states that the flipped classroom is a method in the learning process where students first study subject matter at home before class begins. Even though the flipped classroom is something new in the world of education, several empirical studies have been conducted and flipped classroom learning can be implemented in science lessons.

Basically science is the initial foundation in making students instill three essential domains in the learning process, namely cognitive (knowledge), affective (attitude), and psychomotor (skills) in order to study knowledge based on theory or concept by studying natural phenomena or events through observation. and experiments carried out in everyday life (Bakhtiar, 2019). The aim of science education is preparing students consumers of knowledge and as citizens (Wakhidah & Laelasari, 2022).

Science, as a body of knowledge, encompasses concepts, facts, and theories that are the results of scientific inquiry. Acquiring this body of knowledge necessitates following a series of methods or processes (Kamala & Minhalina, 2022). The essence of science lessons according to Sujana (2013) contains three main points including (1) Science as a scientific attitude, meaning the attitude that is embedded in scientists in seeking, discovering, and developing knowledge, (2) Science as a product, meaning that the products discovered by humans are the fruit of analytical and empirical activities which are essentially obtained through the development of science. Science products contain theories, concepts, facts, laws, and principles that are useful in describing natural phenomena, and (3) Science as a process means that the science learning process is intended so that students are serious about learning a science in order to study natural phenomena.

Flipped classroom learning model supports the 4.0 industrial revolution and 21st century learning (Qader & Arslan, 2019) because it utilizes technology. The flipped classroom learning process in science subjects can improve conceptual understanding and problem solving skills (Khofifah et al., 2021). Based on this, flipped classroom in science learning can be implemented by combining technology and problem-solving questions, moreover coupled with group discussions. The combination of the flipped classroom model with problem solving will create an authentic learning atmosphere (Chis et al., 2018). Such a learning atmosphere and the added learning process to find solutions to problems solving problems in everyday life will train students to think creatively and be able to solve problems. In addition, students who study with group discussions can also practice collaborative skills with their group mates. This makes students accustomed to creativity, problem-solving, and collaborative processes and it is hoped that this habit will continue in the future.

Collaborative Problem Solving (CPS) skills are defined as a person's expertise or ability to work in a complementary team to solve a particular problem and find the best

solution. Collaboration or cooperation refers to completing tasks through interaction among group members in other parts of the world or even solving problems with computer-generated teams (Stadler et al., 2020). OECD (2018) explains that collaborative problem-solving skills mean students' ability to solve problems in groups during learning through conveying ideas and efforts as well as the construction of knowledge and skills in finding solutions to existing problems. This skill trains them during teamwork to discuss and build on existing knowledge with the initial information they have (Hannania et al., 2022).

Based on this, the implementation of a flipped classroom that works together during team discussions can stimulate students to understand material by watching videos or through digital media by preparing questions or problems that they do not understand. Meanwhile, in class, students play an active role in problem solving (individually or in groups), discussions or group activities (Sohrabi & Iraj, 2016). Student activity in interacting through active learning can increase knowledge retention (Susanti & Hamama, 2019). Then the problems found can be solved by finding solutions together so that students' creative thinking skills are trained during the learning process.

The basic idea of learning Flipped Classroom is providing teaching before entering class through videos provided by the teacher online, so that class time becomes more effective with other active activities (Lo & Hew, 2017). According to several studies, Flipped Classroom has lots of face-to-face interactions, collaborations, and discussions with peers that enable students to have a deeper understanding of their knowledge (Hwang & Chen, 2019). Flipped Classroom makes students have more responsibility, especially when studying at home (Avery et al., 2018). Class time is used effectively and has more time to discuss students' doubts and solve many problems (Kittur, 2016). The application of offline and online learning will create time and space while in the class itself so that there is time for solving problems encountered during learning (Karabulut-ilgu et al., 2017).

Learning with Flipped Classroom also makes students have higher motivation than ordinary learning (Asiksoy & Özdamli, 2016). Flipped Classroom accompanied by Collaborative Learning brings out three soft skills such as; communication skills, collaboration skills, and ICT literacy, the learning model makes it easier for students to understand subject matter inside and outside the classroom, learn subject matter, help passive students, and can be used as a guide in doing assignments and preparing tests (Paristiowati et al., 2017). In addition, problem solving can also be trained in this learning activity through assignments in class. Students need opportunities to solve complex problems.

Collaborative Problem Solving (CPS) refers to the process of approaching problems responsively by working together and exchanging ideas for complex problems (Karabulut-ilgu et al., 2017) . Collaborative problem solving skills give students the opportunity to work collaboratively to solve problems with a more explicit process while interacting with others which leads to conceptual understanding and greater task management (Scoular & Peduli, 2019) . In addition, collaborative learning makes students actively participate in groups (Supena et al., 2021), so that students can process the information obtained and provide a

conclusion. This is also in accordance with Humaira (2015) which suggests that the CPS learning process encourages students to express opinions and find solutions to problems, and if CPS learning is carried out properly it will have a good effect on cognitive abilities.

In this study an active learning strategy was used, namely Collaborative Problem Solving. This learning strategy is a construct of two components, namely problem solving and social collaboration. Problem solving sharpens students' cognitive components so that students are able to solve problems and find solutions to these problems, while social collaboration plays a role in interacting with other participants. The combination of these two components determines soft skills that are interdependent in finding solutions and solving problems (Herborn et al., 2018)..

Continuation of the thought process during learning can improve collaborative skills and problem solving. This is an alternative solution for teachers to practice collaborative problem solving for students by implementing flipped classroom learning during the learning process. Learning with Flipped Classroom makes students develop their ability to be creative and innovative because by learning Flipped Classroom students are able to define and analyze problems, generate original ideas, explore various options, including various complex points of view, produce strong complex arguments, and communicate complex arguments by focusing on main ideas, whereas with collaborative problem solving students can discuss collaboratively to generate certain ideas and ideas (Karyadi et al., 2020).

The learning process with flipped classroom can improve collaborative problem solving skills because during learning students experience five behaviors, namely 1) analyzing and understanding a problem, 2) solving problems individually, 3) comparing and exchanging information, 4) interacting with colleagues, and 5) interact with teachers regarding the problems being solved (Karabulut-ilgu et al., 2017). The flipped classroom teaching and learning model is a teaching and learning model modern where the teacher does not control the class completely. Teaching and learning model this make students more productive and creative (Purwijaya et al., 2023). Application of the flipped classroom in learning focused on direct interaction in the classroom, allowing teachers to provide guidance which is deeper and supports student understanding collaboratively (Irfan et al., 2024).

Thus, it can be said that flipped classrooms in online learning can improve students' collaborative problem-solving skills. This was also conveyed by Karyadi et al., (2020) that learning using a flipped classroom combined with Collaborative Problem Solving makes students accustomed to exchanging ideas and opinions which can train students' critical thinking skills to be better. Because the key to flipped classroom success is to encourage students to play an active role in applying new knowledge to different contexts in creative ways (Capone et al., 2017). Through flip ped learning, student-centered learning facilitates learning and actively participates in learning activities (Karabulut-ilgu et al., 2017).

Conclusion

The role of technology in flipped classroom learning provides an overview of the quality of learning using technology. Flipped Classroom can be implemented when it takes advantage of the advantages of face-to-face and online learning. In designing a flipped classroom, it is necessary to pay attention to the constituent components and the challenges faced. Flipped classrooms provide opportunities for collaboration and interaction that are beneficial in mastering collaborative problem-solving skills. In this case the flipped classroom in online learning can improve students' collaborative problem-solving skills.

Credit Authorship Contribution Statement

Rina Rahayu: Conceptualization, Methodology, Visualization, Resources Writing - original draft, Writing - review & editing, Project Administration. **Riva Ismawati**: Conceptualization, Formal analysis, Resources, Writing - review & editing. **Winarto**: Conceptualization, Formal analysis, Supervision.

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