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Blended Learning Program Based on Multiple Representations: Needs Analysis to Stimulate Complex Problem Solving and Reduce Learning Loss

Munadhirotul Azizah[1], Kartini Herlina[1]*, Abdurrahman[1], Nur Arviyanto Himawan[2]

[1]Postgraduate Program Master of Physics Education, University of Lampung, Lampung, Indonesia
[2] Open University, Jakarta, Indonesia

*Email: kartini.herlina@fkip.unila.ac.id

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Abstract. Various complex problems arise along with the increasingly massive development of science and technology in the 21st century. Special skills are needed to survive and adapt to a complex environment and demand various problems to be solved. This study aimed to determine the need for developing multiple representations-based blended learning programs to stimulate complex problem-solving (CPS) and reduce learning loss. This study uses a qualitative descriptive method to provide an overview of the implementation of CPS in high schools and the learning loss during lessons during the Covid-19 pandemic. This research was conducted in July 2022. The data source was obtained using a non-test technique in the form of an open questionnaire. The subjects in this study were 13 physics teachers and 25 students spread across 4th provinces in Indonesia, including Lampung, DIY, Central Java and West Java. The data analysis technique is the Milles & Hubberman analysis technique carried out continuously until the data is saturated. Data analysis involves three steps, data reduction, data presentation, and concluding/verification. Study result show that CPS has yet to be fully implemented in physics learning in high schools. Learning during the Covid-19 pandemic was ineffective and maximal, which resulted in most students experiencing setbacks in learning and a decrease in academic progress (learning loss). Therefore, developing a blended learning program based on multiple representations is necessary to stimulate complex problem-solving and reduce learning loss.
Keywords: Blended Learning Programs, Multiple Representations, Complex Problem Solving, Learning Loss

Introduction

The massive development of science and technology has made the barriers between areas of life increasingly thin. In the 21st century, the world is faced with an increasingly complex environment that requires solving various problems (Fischer et al., 2012; Schefer-Wenzl & Miladinovic, 2019). The problems encountered sometimes require more than one solution and are related to other problems, so special skills are needed to solve them. Complex problem solving (CPS) is considered an increasingly important skill in both professional and personal life (Binkley et al., 2012; Funke et al., 2018) that everyone must possess to survive in the 21st century (Dörner & Funke, 2017). Complex problems can be characterized as unclear problems, both the root causes, the purpose of solving them and how to solve them, so that often the solutions carried out can involve other unexpected variables that are not even related to the problem. The characteristics of a complex system are 1). Complex problem situations; 2). connectivity and dependency between the variables involved; 3). dynamic situation; and 4). variables are not transparent. In a situation, goals lead to conflicting goals at various levels (Fischer et al., 2012). Looking at the CPS in more detailedly and following a functionalist approach, creating a decent representation can increase information search and find concrete solutions (Vollmeyer et al., 1996). According to behavioural theory by Dörner (1986), complex problem solvers must (1) collect information systematically, (2) integrate the most relevant information, (3) know how to build mental models, (4) make and evaluate forecasts plans and decisions and (5) set and evaluate goals. Various cognitive processes are involved in solving complex problems (Eichmann et al., 2019c). CPS is critical to succeeding in a constantly changing environment with sometimes unknown issues (Graesser et al., 2018; Greiff & Fischer, 2013). Gathering information about critical CPS processes is the basis for making students better problem solvers and preparing for future challenges (Eichmann et al., 2019a).

The close relationship between CPS in all aspects of life makes it essential to practice this skill, especially during the learning process. However, research on this topic has so far been limited. Several previous CPS studies have led to evaluation (Bhagat & Spector, 2017; A. Graesser et al., 2017; Greiff & Fischer, 2013; Herde et al., 2016; Molnár et al., 2017), exploration (Dörner & Funke, 2017; Eichmann et al., 2020), and planning (Eichmann et al., 2019b). Schefer-Wenzl & Miladinovic (2019) designed a blended learning curriculum focusing on didactic methods in teaching CPS to engineering students. Unfortunately, the CPS development design is still limited to engineering with software integration and cannot be applied to high school learning, such as physics. Physics is a subject that is closely related to life. Physics makes a significant contribution to the development of technology in the world. Physicists continue to innovate to solve various existing complex problems. Seeing this fact, CPS skills need to be trained during learning at school. Direct current electricity is one of the physics materials that can stimulate CPS skills. Direct current electricity is very closely related to everyday life and requires various problems to be solved. Another problem faced is students who tend to solve direct current electricity problems, not in a systematic, random, and guessing manner (Citra et al., 2021). This shows that students' CPS ability on this material is still low.

Apart from that, the physics learning process also experienced various limitations, especially during the covid-19 pandemic. School closures during the covid-19 pandemic have deprived students of the education they need (Aucejo et al., 2020; Wyse et al., 2020). This prompted the government to issue policies to implement distance learning, which impacted students who lost many learning opportunities and experienced learning loss (Tomasik et al., 2021). Learning loss is defined as the absence of optimal learning processes in schools (Li et al., 2020). Learning loss refers to a general or specific loss of knowledge and skills or a reduction in academic progress, usually caused by extended gaps or discontinuities in education (Kurniawan & Budiyono, 2021). Data from the United States suggests that students of colour may lose 3 to 5 months of study time, while white students lose only 1 to 3 months (Dorn et al., 2020). The research results in Ghana show that within three months, there is an average learning loss of 66% of the previous learning gain during the transition period (Sabates et al., 2021). According to a World Bank study, Indonesian students have lost 0.9 years or around ten months of school learning since the beginning of 2020 due to the covid-19 pandemic (Yarrow et al., 2020). A survey of teachers also found that students experienced learning loss characterized by skipping assignments and lower test scores (Chen et al., 2021). These effects can affect the financial well-being of some students for the rest of their lives.

Physics learning during the pandemic also experienced significant obstacles. The characteristics of the topics discussed in physics are complex and consist of various representations, making it difficult for students to understand the material, especially if learning is only done online. One topic that requires special attention because of the many levels of difficulty experienced by students is direct current electricity. On this topic, many students experience learning difficulties in almost every sub-topic, namely electric current strength, ohm's law, conductive resistance, Kirchoff's law, and energy and electric power. These learning difficulties are caused by low mastery of concepts, weak students' mathematical calculation skills, lack of ability to convert units (Wahyuni & Handhika, 2019), and lack of variety of media and learning methods (Nofitasari & Sihombing, 2017).

Several studies offer solutions to overcome learning loss, one of which is the Heroe online learning model (Kurniawan & Budiyono, 2021). However, this model is still limited to a case study on a limited subject and has not been tested empirically involving more subjects, including Physics. Another solution offered is the gamification method, which positively impacts learning (Hidayat et al., 2021). However, the use of this gamification method is mostly applied to learning in elementary schools (Purniasih et al., 2020; Putrama & Suyasa, 2020; Qodr, 2020; Tangkui & Keong, 2020) and students with special needs (Pradnyana et al., 2020). No research specifically discusses the application of this method in learning physics in secondary schools. In addition, the use of multiple representations (MRs) in blended learning programs is seen as improving CPS skills and reducing learning loss. Blended learning is defined as a learning approach that combines face-to-face learning in class with asynchronous and or synchronous online learning (Wu et al., 2010). An effective Blended Learning environment includes face-to-face interaction in class, online content, assignments, announcements, synchronous conversations, asynchronous forum discussions, and online chat (Calderón et al., 2021). Learning with MRs means using two or more external representations simultaneously (Ainsworth, 2006). MRs allow educators/teachers to display various concepts using verbal methods, pictures, graphs, diagrams, tables, or mathematical equations simultaneously (Abdurrahman et al., 2019). Research on learning with MRs shows that student performance improves when interacting with appropriate representations (Fatmaryanti & Nugraha, 2019; Lucas & Lewis, 2019; Munfaridah et al., 2021). Some researchers (Citra et al., 2020; Fatmaryanti & Nugraha, 2019; Opfermann et al., 2017) have also found that external MRs can help students understand concepts and help them solve problems.

Physics lessons, one of which is the topic of direct current electricity, often use more than one representation, for example, in the form of text, mathematical equations, graphs/diagrams, pictures, verbal or 4-dimensional representations in the form of teaching aids in explaining the concepts. The use of MRs in physics learning is a particular need for students to learn about the given concepts and mediate their cognitive processes in solving physics problems (Kohl & Finkelstein, 2017). This is also an alternative to facilitate the diverse learning needs of students, especially in studying physics. In addition, the blended environment provides firm support and creates opportunities for students to be actively involved in shaping their learning (Montgomery et al., 2019), it can also encourage their involvement in collaborative discussions and motivate them to perform assignments (Suana et al., 2019). Through appropriate learning programs, students will be able to develop their CPS skills and minimize the effects of loss in learning. Thus, the purpose of this research is to find out the need for the development of a blended learning program based on multiple representations. The findings also provide a glimpse into the profile of CPS implementation in secondary schools. The results of this research are expected to be the basis for developing multiple representations-based blended learning programs to facilitate complex problem-solving skills and reduce learning loss.

Methods

This study uses a qualitative descriptive method to provide an overview of the implementation of CPS in high schools and the learning loss during lessons during the Covid-19 pandemic. Descriptive research is collecting information based on facts found in the field (Arikunto, 2019). Qualitative research helps us to understand individual points of view, describe the process, and explore detailed information about the research subject. This research was conducted in July 2022. The subjects in this study were 13 physics teachers and 25 students spread across four provinces in Indonesia, including the provinces of Lampung, DIY, Central Java and West Java. Participants in this study were selected based on a purposive sampling technique, provided they had studied physics on the topic of direct current electricity and agreed to be research subjects.

The data collection procedure uses a non-test technique in the form of an open questionnaire with reasons for each answer. After all the information from the questionnaire was complete, triangulation of data sources was carried out to draw conclusions. The data analysis technique used is the Miles & Huberman analysis technique (2018), which involves three steps: data reduction, data presentation, and drawing conclusions/verification. Reduction means grouping the important thematically and removing the unnecessary. Data display is to understand what happened and plan the next steps—making/reviewing conclusions by answering or not answering problems because qualitative research is temporary and develops after study in the field.

Results and Discussion

Identifying problems found in the field using non-test techniques in the form of open questionnaires was carried out on 13 physics teachers with different backgrounds and teaching experiences. The following table is a generalization of the answers of the 13 predetermined teachers.

Table 1. Problem Identification Results

No.	Indicator	Teacher Response
1	Learning conducted during the covid-19 pandemic	Offline, online and blended.
2	The learning method used	Lectures, discussions, demonstrations, experiments, practicum.
3	The difficulty factor in learning direct current electricity	Limitations of tools for practicum, limitations of learning media, limitations of media and teaching materials that can display various representations simultaneously and limitations of internet signals
4	Direct current electricity topics that are difficult for students to understand	Series-parallel circuits, Kirchoff's laws, determine the branching of currents, imagining the actual flow of current, energy and electric power.
5	Application of multiple representations in learning	Not quite yet.
6	Multiple representations content in teaching materials	It exists but doesn't cover everything.

7	Content of multiple representations on LKPD	It already exists, but there are those who haven't used it. Because the LKPD that is made is just a trial guide as usual.

The results of problem identification show that physics learning is carried out in schools quite varied with the use of learning models and methods that tend to be student-centered, not only lectures but also the teacher encourages students to carry out discussions, experiments, demonstrations, and practicums. However, teachers experience several obstacles in teaching the topic of direct current electricity, namely limited tools for apprenticeship, biased learning media, narrow internet signals, and fixed media and teaching materials that can display various representations simultaneously. Using the suitable representation can improve student performance, especially in understanding concepts and solving problems (Lucas & Lewis, 2019; Opfermann et al., 2017). However, this still needs to be fully implemented in learning, teaching materials, and LKPD. Similar findings were also obtained by Putri et al., (2022) that most teachers have yet to use appropriate learning strategies, methods, and visualizing concepts in multiple representations.

Even though physics learning in schools tends to be student-centered, CPS still needs to be fully implemented in education. Apart from that, there is still learning loss that occurs to students during learning during the pandemic. The following is a more detailed description of the findings regarding CPS and learning loss in the field.

CPS Analysis

From the findings from the non-test questionnaire identification results that were distributed, it was found that some teachers had indirectly carried out activities that led to CPS, but the overall learning process that took place had not been explicitly aimed at training CPS. It is known from the fact that all CPS indicators have not been included in learning activities, teaching materials, and worksheets used by teachers. Time limitations during online and offline learning during the pandemic and the large amount of material that had to be completed resulted in understanding focusing on solving math problems and choosing only core materials to be delivered without paying attention to the CPS skills acquired. The LKPD used by the teacher is still limited to summarizing material, practicing questions, and completing practicum activities in general and has not led to CPS training. The following table is a generalization of the findings of CPS implementation in schools.

Table 2. Results of Identification of CPS in schools

No.	Indicator	Teacher Response
1	Learning trains students to collect information in a systematic way	Already by conducting experiments, collecting data, preparing experimental reports, group discussions, process skills; studying modules; videos and home studies and provide practice questions. Some have not, due to conditions that are not yet possible and still do not support students.

No.	Indicator	Teacher Response
2	Learning trains students to integrate information that is most relevant	Already by analyzing data collection, using digital measuring tools, learning videos, given problems in the form of cases, drawing conclusions, conveying measurement results, and presenting results. Some haven't, because the information comes only from the teacher, only focusing on solving math problems, and the time constraints with the amount of material to work on, so that only the core material is learned.
3	Learning trains students to build mental models from various problem-solving options	Already by developing a small project based on the stimulus, working together in groups to experiment. Not yet, because it only focuses on solving calculation problems. Time constraints with the amount of material that must be worked on. So that only the core materials are learned. Students are still carried away by the atmosphere of online activities during the pandemic.
4	Learning trains students to make predictions, plans and decisions	Already, by involving students in planning the development of prototypes from YouTube then deciding to design and solve problems, make conclusions, discuss for processing and analysis of experimental data and provide practice questions. Some haven't, because they only focus on solving calculation problems and not project base.
5	Learning trains students to implement plans by linking and adjusting action steps as needed to overcome problems	Already, by directing students to explain solving problems based on activities that have been carried out, conducting experiments, collecting data and reading measurement results. Not yet, because I only focus on solving calculation questions. Practical instructions are already available in the LKPD and you just need to follow them

The first question was about student involvement in collecting information systematically, and most of the teachers answered that this activity had been rehearsed during the lesson. However, some of the answers given did not provide detailed information regarding the activities carried out and did not represent the intent of the questions asked. This relates to how students can collect essential information systematically, especially when faced with a complex problem. For example, in learning direct current electric circuits in the series-parallel circuit sub-matter, students are faced with the problem of how to connect a lamp to a circuit that has an electric current source that produces a certain potential difference if the lamp has a certain power and potential difference, where should the lamp be placed? And how the circuit should be arranged. This certainly requires deep thinking, where students need to collect basic information first to be able to solve the problems presented, such as knowing what circuit to use, how many resistances need to be installed, the concept of voltage, current strength and resistance and their relationship with power, and so on. Students are expected to understand physics concepts and apply the concepts they know when solving problems (Wardani et al., 2021). This is one of the critical characteristics of complex problems, i.e. they contain some degree of non-transparency where not all information is available from the outset (Gnaldi et al., 2020). One is often confronted with new problems characterized by uncertainty, connectivity, lack of transparency/ambiguity, and complexity (Grežo & Sarmány-Schuller, 2022). Complexity means that a complex problem involves a set of interrelated variables in which several causal relationships are established. Interconnectivity, on the other hand, implies some degree of dynamics because systems may change over time. This change can be driven by input from the problem solver or by the development of momentum during the problem-solving process (Gnaldi et al., 2020). Therefore, gathering information from various sources that can help find pieces of the problem is the primary key that needs to be done.

The teacher's response to the second question regarding student activities in integrating the most relevant information indicates that these activities still need to be fully carried out during learning. Some teachers who answered that they did not practice these activities gave the excuse that the information was only provided by the teacher and time constraints were the cause of the intended activities not being carried out so that the learning process only focused on conveying the core material and solving math problems. Although some teachers answered that the activity had been trained, the method of training described needed to represent the intent of the questions given. This means that the teacher may need help understanding the purpose of the activity. The purpose of integrating the most relevant information here is that after collecting various sources to find pieces of the problem that are not yet clear, students sort and integrate one piece of information with other information, which can be a guide for finding problems and creating solutions. For example, after some information is obtained, such as the concept of voltage, current and resistance and their power relationship, the purpose of a lamp that has a specific power and potential difference, students integrate the most relevant information to form an appropriate problem-solving framework.

The lack of information transparency requires the problem solver to interact actively with complex systems to uncover hidden relationships. Otherwise, the real problem will remain undetected. In other words, without processes to proactively address problems, relevant information remains hidden and planned and targeted solutions to problems are impossible (Gnaldi et al., 2020). As already mentioned, in complex problems, the situation can change dynamically, and only some of the information needed to find a solution is presented beforehand. In this case, it isn't easy to make a complete plan before doing it (Eichmann et al., 2019a). Therefore, sorting and integrating some information is crucial to make it easier for students to determine solutions. Integrating, synthesizing problems, and analyzing data directly can develop CPS capabilities (Putra, 2021). The ability to solve complex problems is usually measured through dynamic systems that contain several interrelated variables that need to be changed (Dörner & Funke, 2017).

The third question related to student involvement in building mental models of various problem-solving options. Some of the teachers answered that they had trained them in group discussion activities and doing small projects based on a stimulus. However, the activities mentioned were still general. They should have explained the discussion and creation of what kind of project and how it was carried out so that the activities in question could emerge. The cognitive framework of solving problems suggests that a problem can be tackled through various problem-solving techniques. For example, when faced with a problem where a lamp can be connected so that it still has a distinct predetermined potential difference, students can use a mathematical equation or represent it in other forms, such as pictures or circuits. In complex systems, learning can only occur at a very general and abstract level because it is difficult for human observers to make specific predictions. The way to deal with complex systems is very different from the way to deal with ordinary systems. Pure learning effects, multi-key probabilistic learning or tasks solved by a single strategy should not be studied under the CPS label (Dörner & Funke, 2017). A systematic way of exploring complex problems may be directly related to constructing a correct mental representation of the problem (Greiff & Fischer, 2013). Building a mental model when involved with complex problems is highly recommended because it helps students break down information that is not transparent.

As for the response to the fourth question related to training students to make forecasts, plans and decisions, the teacher who answered had yet to do so, considered that the learning activities carried out were not project-based and problem-based, so this could not be implemented. Whereas the teacher who answered that he had done so gave a clear description of the activities, what problems were given, whether they were related to complex systems or ordinary systems were not explained in detail. When dealing with complex systems, making forecasts, plans and decisions cannot be done just like that but must involve the three previous components: systematically collecting information, integrating the most relevant information, and creating a mental model of a problem. If the previous components are not met, making forecasts, plans and decisions when dealing with complex systems is not easy. This is in line with the statement expressed by Dörner & Funke (2017) that solving complex problems is not a one-dimensional and low-level construction. Complex problem-solving is a series of self-coordinated psychological processes and activities required in a dynamic environment to achieve vague goals that everyday behaviour cannot achieve. This requires a creative combination of knowledge and various strategies. The solutions obtained often come from unexpected things. The problem-solving process incorporates cognitive, emotional, and motivational aspects, especially in high-stakes situations. Complex problems usually involve knowledge requirements and collaboration between different people.

On the fifth question, some teachers answered that students had been trained to implement plans by connecting and adjusting action steps as needed to solve problems. However, the activities carried out have yet to represent the desired answer fully. Explaining problem-solving, conducting experiments and, reading measurement results, discussing data collection and analysis are some of the activities that the teacher describes to train them. More than that, establishing an action plan and adapting as needed relates to setting and balancing goals to find solutions to complex problems based on the mapping of problems that have been done. CPS is a dynamic process that scales over time, with distinct phases beyond knowledge acquisition and application. A process that leads to a solution, including detours and mistakes, can give a more precise impression of a person's problem-solving skills and abilities than the result. That is one of the reasons why this test is not a complex intelligence test. Research on CPS is not only about the decision-making process results but also about the problem-solving process itself (Dörner & Funke, 2017).

Based on the description above, the results show that CPS still needs to be fully implemented in physics learning. The answers and descriptions explained by the teacher indicated that some teachers needed to fully understand the CPS indicators so that there was confusion in practising them during the learning process. CPS competence is the main competency that students must have, especially to face the challenges of the 21st century. Glazewski & Ertmer (2020) advocates an approach to teaching complex problem-solving that requires a deeper understanding of and commitment to culturally relevant education. These shifts in practice are guided by an understanding of students' cultural context, addressing critical reflection coupled with meaningful action, and generating problem-solving designs that promote identification with the discipline. The characteristics of complex problem-solving environments help teachers go beyond standard practices and take meaningful actions that help bridge educational gaps. CPS ability is associated with environmental factors of students by providing various feedback and brainstorming (Putra, 2021). Students with higher CPS abilities can use prior knowledge more proficiently when learning new content; thus, their learning is faster and more profound. CPS has been considered an indicator of academic achievement and a leading indicator of achievement in other skills. Given the increasing importance and needs of CPS today and in the future, students' abilities are not accompanied by an increase in complex problem-solving abilities, so continuous research is needed to improve students' CPS abilities (Asfar et al., 2021). Increasing CPS's ability can be trained during the learning process, so it is necessary to develop a learning program that can train CPS.

Learning Loss Analysis

Nine out of 13 teachers reported that learning during the Covid-19 pandemic was not effective and optimal. Several factors cause the ineffectiveness of learning during a pandemic. The following table is a summary of teacher responses to learning effectiveness and learning loss that occurs in schools.

Table 3. Teacher responses regarding the effectiveness of learning during the pandemic and indications of learning loss

No.	Indicator	Teacher Response
1	The effectiveness of learning implemented during the Covid-19 pandemic	In general it is still not effective because students are still carried away by online learning so they are a little lazy when in class, many hours are cut so that the material and learning model provided are not optimal, environmental conditions and student psychology are not conducive, and signal limitations and the environment is not supportive.
2	Indications of learning loss experienced by students during learning that was implemented during the Covid-19 pandemic	Student discipline is reduced from starting class hours, students rarely submit assignments, then the internet is limited, due to time constraints in the implementation of learning, students tend to be busy playing games a lot.

Some teachers stated that there were no problems in learning because they had done face-to-face meetings. While for others, even though learning has been carried out face-to-face, the reduction in the allocation of class time, environmental conditions and student psychology that is not conducive and students who are still carried away by the atmosphere of online learning are obstacles that result in less effective learning. As for schools that carry out learning activities online, limited internet signals and an unsupportive learning environment are different obstacles to learning activities. In addition, teacher readiness to carry out online learning also impacts learning effectiveness. Research by Fajriana & Safriana (2021) reveals that physics teacher readiness in implementing online education is ready but requires a slight increase in ability on the medium scale, including the teacher's ability to implement online learning, which can improve the teaching and learning process, teacher concern in implementing online learning in schools and the ability to integrate online learning with classroom learning.

The ineffectiveness of the learning carried out impacts the number of students who experience setbacks in learning and a decrease in academic progress (learning loss). Most teachers admit that their students experience setbacks in learning and a decline in academic progress. Some student behaviours that rarely submitting assignments reduced discipline when entering class, tending to be busy playing games, and decreased academic scores indicate symptoms of learning loss experienced. In addition to external factors, the teacher reported several things that became a factor of difficulty in carrying out learning. These factors include limitations to internet signals, limitations of tools for conducting practicums, limitations of learning media, and limitations of media and teaching materials that simultaneously display concepts with various representations.

This is in line with the student's perspective. As many as 18 out of 25 students admitted that the learning during the Covid-19 pandemic was not effective and maximal. This ineffectiveness is influenced by several factors, including difficulty understanding the material, lack of direct explanation from the teacher, difficulty focusing during learning, limited time for learning to limited internet networks. As many as 17 out of 25 students admitted to experiencing a setback in learning and a decrease in academic progress. While the rest said, they could cope by signing up for tutoring outside of school, studying more actively at home, repeating the material they had learned and looking for additional material through several websites on the internet. Students who responded that online learning during the pandemic remained effective and optimal were probably due to the increased independence of the student's learning. Students' attitudes toward online learning are very important. Having a positive attitude towards online learning can affect their learning process (Maison et al., 2021). Online learning encourages students to study independently and explore other things. This activity can help improve students' thinking skills. This can be seen as one of the positive aspects of implementing online learning. Although of course, not all students can adapt and learn independently (Rajib & Sari, 2022)

The emergence of a paradigm shift in teacher-directed learning systems, such as the virtualization of face-to-face learning and gadgets, has developed an opinion about the emergence of learning loss in students. Because the material available on various internet platforms tends to provide brief content, some children may need help understanding the material presented (Rizaldi et al., 2022). Students have relatively low self-confidence in dealing with learning problems. When students receive questions or assignments from subject teachers, they tend to immediately seek answers from various internet sources without verifying the answers' correctness. Very few students answered their questions and then looked at various sources as references or benchmarks for the answers given. Although the two conditions look similar, they are very different in terms of the processes students go through. With technology like this, everything is considered easy to get, making students lazy to do anything. This is what every teacher faces when giving assignments and questions to students to do at home. Teachers cannot directly monitor the process of solving student problems during online learning (home learning). Teachers can only see the final results of tasks completed by students (Rizaldi et al., 2022).

Forces to Increase CPS and Minimize Learning Loss

From the findings of the CPS analysis, a brief description is obtained that solving complex problems requires various activities that involve several cognitive processes, but this is only partially present when carrying out learning. The diverse and unique characteristics of students make it a challenge to be able to accommodate learning optimally. Therefore it is necessary to have a strategy to facilitate students' different learning needs, one of which emphasizes learning by using Multiple Representations in conveying the concept. Learning resources related to visualization can be important things that can facilitate students understanding abstract concepts (Apriani et al., 2021) Several learning studies using MRs show that student performance improves when interacting with appropriate representations (Fatmaryanti & Nugraha, 2019; Lucas & Lewis, 2019; Munfaridah et al., 2021). This may indicate that learning loss can be reduced by using MRs. In addition, external MRs can help students understand concepts and help them solve problems (Citra et al., 2020; Fatmaryanti & Nugraha, 2019; Opfermann et al., 2017). The use of MRs in learning can be one of the efforts that can be made to improve students' CPS skills.

Meanwhile, online learning only sometimes has a negative impact on students. Some of the benefits obtained are also countless (Dumford & Miller, 2018; Yuhanna et al., 2020). So that online learning cannot be immediately eliminated. To overcome the disadvantages and still benefit from online learning, blended learning is seen as one of the innovations that need to be adopted (Dangwal, 2017). The blended concept, which combines face-to-face meetings (offline) and meetings through discussion forums (online), is one of the recommended solutions in learning during the past Covid-19 pandemic, transition period, and distance learning (Purwanti et al., 2022). The blended environment provides firm support and creates opportunities for students to actively shape their own (Montgomery et al., 2019), learning so that learning loss can be minimized. Blended learning activities can also encourage their involvement in collaborative discussions and motivate them to perform tasks (Suana et al., 2019) that can support them in solving complex problems. Therefore, using MRs in blended learning programs is seen as an effort to improve CPS skills and reduce learning los-los.

Conclusion

Based on the research results, it was concluded that CPS had yet to be fully implemented in physics learning in secondary schools. Learning during the Covid-19 pandemic was ineffective and maximal, which resulted in most students experiencing setbacks in learning and a decrease in academic progress (learning loss). Therefore, it is necessary to develop learning programs that can support student learning processes independently and under the supervision of teachers at school. A blended learning program based on multiple representations is needed as a learning unit that can stimulate CPS and reduce learning loss.

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