The Effect of the Constructivist Approach on Students' Cognitive Physics Learning Outcomes: A Mini Review

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Abstract

Background: With the development of the times, the education system has also changed. Teacher-centred learning is no longer used because it makes "meaningless learning" for students. This "meaningless learning" impacts student learning outcomes, especially in the cognitive domain. Teachers must have the skills to design learning using an approach, and it is taught in pedagogy.

Objectives: In this article, a literature review focuses on the effect of the constructivist approach on students' cognitive Physics learning outcomes.

Methods: This article compares several pedagogical approaches in general, and then draws on research in Indonesia and Physics. The advantages and disadvantages of the constructivist approach are also explained, as well as how to overcome its weaknesses.

Results: Applying a constructivist approach to the cognitive Physics learning outcomes of students, students' cognitive learning outcomes (including Physics) can be enhanced.

Conclusions: It turns out that there is a relationship between the constructivist's approaches to Physics.

***Keywords**:* Constructivist Approach, Cognitive, Physics Learning, learning loss

1. Introduction

The development and adoption of new technologies have undergone dramatic shifts over the past decade. Numerous enhancements have been made to the human provision of various amenities [1]. The education system is one of the overgrowing facilities, and many have changed [2]. The education system is no longer dependent on teachers as learning centres (Teacher-Centred Learning/TCL approach). It is believed that learning systems in which students receive only prefabricated information from the instructor are less meaningful and provide less experience [3]. Students receive information passively and without experience in an academic environment dominated by the TCL approach [4, p. 35]. According to Andala [5], teacher-centred instruction is the least effective method for improving student learning outcomes, particularly in the cognitive domain. This is also consistent with Scott [3], who describes the weaknesses of TCL that result in meaningless learning and low cognitive learning outcomes for students.

For students to achieve the desired cognitive learning outcomes, teachers must be able to design effective learning activities [6] and its assessment [7]. Effective instruction enables students to comprehend and master the concept of knowledge [8] including the use of media distinguish the student learning achievement [9] and their character [10]. Pedagogy study is one way to improve the quality of teachers [11]. Simply put, pedagogy is the art of instruction [12]. According to Alexander [13], in a narrow sense, pedagogy refers to what the teacher does in the classroom,

particularly in the application of teaching strategies. Pedagogy-based teaching methods include constructivist, collaborative, integrative, inquiry, and reflective approaches [14]–[16], among others.

However, the constructivist approach is the most popular of the numerous available approaches because it is the most effective at achieving learning objectives [17]. The constructivist learning environment includes active actions performed by students, such as the discovery, fusion, and construction of old knowledge with new, distinctive collaboration to foster creative thinking [18], [19].

It has been discovered that there is a correlation between the constructivist approach and the cognitive learning outcomes of students. Previous research has demonstrated that a constructivist approach improves the cognitive learning outcomes of students [1], [18], [20], [21]. In Indonesia, the constructivist approach is also frequently used and has a positive influence on student learning outcomes [22], [23].

Given the preceding explanation, it is crucial to understand the effect of the constructivist approach on the cognitive learning outcomes of students. This finding can later be used by educators as a factor in achieving learning objectives. This article can also contribute to the enhancement of overall student performance, including cognitive learning outcomes. We hypothesise that constructivist learning influences student achievement.

2. Objectives

This paper seeks to determine the impact of constructivism on the cognitive learning outcomes of students.

3. Methods

This paper was compiled using the method of literature review. Various data sources are combined and processed, and references from relevant books, journals, and research reports are extracted.

4. Results

Learning Approaches

To achieve the desired student learning outcomes, teachers must be able to design effective learning in concept construction, comprehension, and mastery [8]. Studying pedagogy is one way to improve teachers' classroom management abilities [11]. Pedagogy is a teaching science that contains methods for designing instruction to facilitate the learning process and classroom environment [24]. Simply put, pedagogy is the art of instruction [12]. According to Alexander, [13] is interpreted in a narrow sense, referring to what teachers do in the classroom, particularly with regard to implementing teaching methods. According to pedagogy, there are numerous teaching methods, such as constructivist learning approaches, collaborative learning approaches, integrative learning approaches, inquiry learning approaches, and reflective learning approaches [14]–[17], among others.

The collaborative approach (CL) is a method that entails working in small groups on specialised projects. This method is commonly known as cooperative learning [25]. In this method, knowledge is acquired by a group whose members interact actively [26]. Every member of the group shares

their thoughts and experiences. In conclusion, this strategy emphasises student cooperation or collaboration.

In the integrative method, students create new knowledge and experiences by combining their existing knowledge and experiences. With integrative, students will take the edge of their existing skills and apply them to new, more complex experiences [27].

The Inquiry-Based Learning (IBL) method emphasises students' natural curiosity and desire to comprehend knowledge. This strategy encourages students to pose questions and investigate and explore for answers. Thus, students will experience learning and retain information longer [3], [28].

The reflective approach encourages students to consider their past experiences and actions. The purpose of reflection is to determine the significance of each event in order to construct a conceptual perspective [29].

According to constructivist theory, knowledge is the result of the active construction of new knowledge by students [30]. Constructivist teaching and learning does not necessarily involve an instant transfer of knowledge from teachers to students; rather, students must construct knowledge or concepts based on their own experiences [18]. Constructivism emphasises student engagement in all interactions so that they can explore and construct their knowledge [20], [31], [32].

According to the preceding explanation, each approach has distinct characteristics. There may be similarities in its application, however. Previous research employing the aforementioned methods has yielded a wide range of results.

Relevant Research on Learning Approaches

Ereje [16] investigated the connection between the learning strategy and student learning outcomes. Among a number of pedagogical approaches, the constructivist approach received the highest average score (4.32), while the reflective approach received the lowest (4.08). (4.03). The most effective approaches are constructivist, inquiry, integrative, collaborative, and reflective, in that order. The study's outcomes are presented in Table 1. In general, the results demonstrate that the application of various pedagogical approaches to student learning outcomes results in significant differences. In addition, among pedagogical approaches, the constructivist approach is the most satisfying.

TABLE 1 Satisfactory of Learning Approach Based on Student's Cognitive Learning Outcomes

Indicator	Mean	Interpretation
Constructivist Approach	4.32	Satisfactory
Inquiry-Based Approach	4.22	Satisfactory
Integrative Approach	4.17	Satisfactory
Collaborative Approach	4.07	Satisfactory
Reflective Approach	4.03	Satisfactory
Average Mean	4.19	Satisfactory

Legend: “Poor (1.00-1.50)”, “Needs Improvement (1.51-2.50)”, “Satisfactory (3.51-4.50)”, “Highly Satisfactory (4.51-5.00)”

According to a report by Rio et al. [17], the most effective teaching approaches are collaborative, constructivist, inquiry-based, reflective, and integration. Table 2 presents the study's findings. According to Table 2, the collaborative approach and constructivist have the greatest impact on student learning. Both approaches can create a more engaging, interactive, and enjoyable learning environment. These findings can enhance classroom performance and student achievement in general, including cognitive learning outcomes.

TABLE 2 Rank of Learning Approaches Based on Student’s Cognitive Learning Outcomes

Pedagogical Approach	Mean	Rank
Constructivist	3.99	2
Collaborative	4.06	1
Integrative	3.60	5
Inquiry-Based	3.83	3
Reflective	3.80	4
Average Mean	3.86	

Another study by Miguel [14] demonstrated that the most effective method was the collaborative method, which was rated as very effective (mean of 4.74). According to the mean, the reflective approach is the least effective (3.79). These results are displayed in Table 3.

TABLE 3 Effectively of Learning Approaches Based on Student’s Cognitive Learning Outcomes

Teaching Approach	Mean	Interpretation
Constructivist	4.00	Effective
Collaborative	4.76	Highly Effective
Integrative	4.11	Effective
Inquiry-Based	4.00	Effective
Reflective	3.79	Effective

Legend: “Not at all (1.00-1.80)”, “Not Effective (1.81-2.60)”, “Fairly Effective (2.61-3.40)”, “Effective (3.41-4.20)”, “Highly Effective (4.21-5.00)”

The aforementioned studies demonstrate that, among other approaches, the collaborative approach and the constructivist approach are acceptable, reasonable, and effective when applied to learning.

Nevertheless, an approach cannot always be deemed successful [17]. This is in accordance with Gardner's Multiple Intelligence Theory [33], which states that each student has a unique learning style [34], a brain that must be stimulated, and mental capacity that must be maximised. The success of the approach depends on the specific subject matter to be studied, the recognition of the diverse needs of students, and the ability to respond to situations in the surrounding environment [16].

In terms of the "surrounding environment," if we restrict our research to Indonesia, the constructivist approach is the most prevalent and demonstrates its efficacy in learning. Wahyuningsih [35] reports that the implementation of constructivist learning can improve mathematics student learning outcomes. Additionally, Harjali [36] asserts that the constructivist approach can enhance the quality of learning in PAI subjects. Other relevant studies supporting the connection between constructivism and student learning outcomes have also been discovered [37]–[39].

It turns out that constructivism has a positive effect on student learning outcomes even when restricted to Physics subjects. According to Saputro [23], constructivist learning through mind map and discussion methods has a significant impact on students' cognitive Physics learning outcomes. Adnyana [8], Subijakto [22], Sihole [40], and Mialisa [41] have also demonstrated that constructivist can improve student learning outcomes in Physics classes.

Constructivist Approach to Physics

The constructivist approach can influence learning outcomes because it allows students to construct their own knowledge based on their unique experiences [42], [43]. According to Barlia [39] and Sutrisno [44], the characteristics of constructivism are that students are not viewed as passive, but as actively engaged in the learning process, and that knowledge is the result of its own unique construction. By constructing old knowledge with new knowledge, students will be able to better interpret learning and remember concepts over time [45].

Therefore, it should not come as a surprise that constructivist can influence Physics learning outcomes. This is due to the interactive nature of learning physics between teachers and students. It can lead to learning experiences that enable students to master the processes and products of physics by constructing Physics knowledge with real-world phenomena [46], [47] The products of physics consist of facts, data, concepts, laws (Newton's laws or Coulomb's laws), principles, rules, theories (kinetic theory of gases, etc.), and models (atomic models, galaxy and models) [48], [49].

Advantages of the Constructivist Approach

According to Honebein [50] and Cano-Fullido & Olusegun [51], the advantages of the constructivist approach are:

- Students are required to actively construct their knowledge. Students do not automatically acquire knowledge.
- Students can use their prior experience and knowledge to acquire new information.
- Learning will be enhanced if students think critically, comprehend, and master concepts, as opposed to simply memorising.

- The constructivist approach emphasises how students construct knowledge. Constructivism can train students' social and communication skills by emphasising collaboration and the exchange of ideas in the classroom.

Harjali [36] also disclosed the same information. The constructivist approach can improve the quality of learning because it requires students to be more dominant, more active in asking questions, discussing, searching for ideas to solve problems, and daring to express opinions based on commonly held beliefs.

The constructivist approach is implemented according to the stages proposed by Yager [52] is shown in Table 4. Constructivism includes a pedagogical approach [53], which we alluded to earlier; there is an inquiry-integrative approach with collaboration at the exploration stage and a reflective approach at the solution-explanation stage. Table 4 demonstrates the benefits of constructivism. Consequently, the constructivist stages are optimal for learning Physics. Not only do students memorise formulas, but they also comprehend and interpret concepts.

TABLE 4 Stages of Constructivist Approach

Stages	Learning Activities
Stage 1. Invitation	Before learning commences, this step identifies students' initial conceptions.
Stage 2. Exploration	This stage allows students to interact with their physical surroundings, engaging them in active exploration of new information. At this stage, students experiment, discuss, analyse, and construct old knowledge using new knowledge.
Stage 3. Solution and Explanation	At this stage, students communicate information and ideas, construct new explanations, review and explore solutions, utilise group evaluation, and combine knowledge and experience with solutions.
Stage 4. Follow-Up and Expansion	At this stage, students cultivate attitudes and behaviours conducive to further development. Students are required to self-study the application and extension of previously learned concepts.

Skill Weaknesses of the Constructivist Approach

Constructivism has a number of disadvantages, despite its many advantages [54]:

- Students construct knowledge with their ideas, which can lead to misconceptions;
- learning is time-consuming;
- not all students desire to be active. Some students are lazy
- Conditions in each school influence students' efforts to acquire new knowledge

Students' misunderstandings pose a significant obstacle to the application of the constructivist approach [55]. Morrison [56, p. 114] asserts that some science teachers assign lab activities to students without using textbooks or providing guidance, leaving students confused and susceptible

to misunderstandings. Similar research conducted by Baines [57] reveals that teachers are too free to provide students with opportunities to build their knowledge, but fail to guide them. In response to this issue, Windschitl [58, p. 752] argues that constructivist instruction must be developed under the supervision of a teacher. As a facilitator, the teacher must always be alert for instances in which students struggle to construct knowledge [59]. If this misconception is not addressed, student learning outcomes will suffer.

5. Conclusion

Applying a constructivist approach to the cognitive Physics learning outcomes of students has an effect. With this method, students' cognitive learning outcomes (including Physics) can be enhanced and learning objectives can be met. This is because the constructivist approach can encourage student participation and knowledge construction. However, guidance must still be provided by the teacher in order for students to avoid misconceptions when using this method.

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