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The Importance of Enactive Processes Through Experiments in Improving Learning Outcomes Based on Bruner's Theory

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Abstract
This study aims to determine the effect of applying the enactive process through experimental activities on student learning outcomes in science education. The enactive process, as proposed by Bruner, emphasizes the direct involvement of students in manipulating objects and conducting real experiences as the basis for concept formation. This study uses a literature review approach to examine scientific publications on the role of enactive processes through experimental activities in improving learning outcomes based on Bruner's theory. Data were obtained from reputable articles on Google Scholar and ScienceDirect that were relevant and up-to-date, then analyzed thematically to reveal the relationship between the enactive process, student engagement, and improved learning outcomes. The results of this study indicate that the enactive process plays an important role in science learning because it directly involves students through experiments, thereby increasing student activity, conceptual understanding, science process skills, and overall learning outcomes.

Keywords: *Enactive process, Learning outcomes, Bruner's theory, Learning*

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INTRODUCTION

Science education in Indonesia has a strategic role in equipping students with scientific thinking skills, understanding of scientific concepts, and 21st century skills such as critical thinking, problem solving, and science literacy. The national curriculum has directed science learning to be contextual, emphasizing the scientific process and linking concepts to everyday phenomena. Through science learning, students are expected not only to master factual knowledge but also to develop scientific attitudes, such as curiosity, objectivity, and the ability to make data-based decisions (Fitri, 2021).

In practice, science learning in Indonesia is still teacher-centered. This can cause children to become passive, afraid to express their feelings, verbalistic, mentally ill, insecure, uncritical, and unproductive (Firmansyah & Jiwandono, 2022). Hutasoit, (2021) explains that the learning process is carried out by teachers through lectures that sometimes only use PowerPoint presentations, making learning passive and monotonous, which causes students to become bored, tired, and unmotivated to learn. Such learning can have a negative impact on many things, one of which is that it can cause students' learning outcomes to be less than optimal.

Based on these problems, science learning needs to be directed towards learning that provides opportunities for students to be directly involved in the learning process. This learning process is often associated with meaningful learning, which allows students to build conceptual understanding through real experiences, rather than simply receiving verbal information from teachers. Nurjihan & Bunawan, (2025) explain that a deep understanding of the characteristics of student learning achievements is very important for designing contextual, differentiated, and adaptive learning strategies. Learning models that only emphasize one-way delivery of material are often unable to optimally build student cognitive engagement. This model places students as the main subjects in learning, where they are encouraged to discover important concepts themselves through exploration, observation, investigation, and drawing conclusions (Herung et al., 2025). In the process, teachers continue to play a role as facilitators who provide direction and support so that learning remains structured but does not limit students' inquiry space.

This is in line with Bruner's learning theory, which emphasizes that knowledge should be discovered by students themselves through direct interaction with objects, phenomena, or problems. Bruner states that the learning process will be more effective if students are given the opportunity to experience, explore, and discover concepts independently (Basyir et al., 2022). Annisa et al. (2025) state that in process learning, cognitivism theory provides a foundation for the importance of cognitive structures, knowledge schemas, and thinking strategies in building understanding. Thus, meaningful learning through direct experience becomes an important foundation in creating effective science learning that is oriented towards conceptual understanding.

Bruner's theory is very relevant in supporting meaningful learning because it places students as active subjects in the learning process. Bruner argues that good learning is learning that encourages students to discover concepts through exploratory activities (Huda & Djono, 2025). In the context of science learning, this means that students not only listen to the teacher's explanations but also make observations, conduct experiments, and engage in discussions to build scientific understanding.

One important concept in Bruner's theory is the stages of learning representation, namely enactive, iconic, and symbolic. The enactive stage is a very important initial stage because students learn through direct action on objects (Zikrulloh et al., 2025). By applying enactive learning, students can gain concrete experiences that form the basis for a more abstract understanding of concepts, so that science learning becomes more meaningful and not just rote memorization.

The enactive process in Bruner's theory is in line with the constructivist view that knowledge is actively constructed by learners through learning experiences. In the constructivist approach, students are not seen as passive recipients of information but as individuals who actively construct their knowledge through interaction with the environment (Rizki et al., 2025). The enactive process provides space for students to learn through physical activities and direct experiences.

The enactive process in science learning can be realized through activities such as experiments, practicums, simulations, and observations of natural phenomena. These activities encourage students to think, ask questions, and draw conclusions based on their observations (Anggraini & Zulkarnaen., 2025). Thus, the enactive process not only strengthens conceptual understanding but also trains scientific process skills, which are the main objectives of science learning.

Emphasis on the enactive process in science learning can be done through systematically designed experiments or practicums. Sarumaha & Harefa, (2022) explain that experiments allow students to directly experience the science concepts being studied, so that learning is not abstract. Through experiments, students can observe cause-and-effect relationships, test hypotheses, and understand concepts based on real experiences.

Learning that emphasizes the enactive process through experimentation also encourages students to be more active, creative, and critical in their learning. Direct involvement in the scientific process makes learning more meaningful because students feel that they have the learning experience (Feriyanti et al., 2025). This is expected to reduce boredom in science learning, which has been dominated by lecture methods, while increasing student motivation and interest in learning.

The application of enactive processes in science learning has the potential to have a positive impact on student learning outcomes. Septiani & Fatonah, (2024) explain that learning outcomes are not only seen from a cognitive aspect, but also from the development of scientific attitudes and science process skills. When students are actively involved in experiments and concept discovery activities, their understanding becomes more profound and lasting compared to learning that is only theoretical.

Various studies show that learning that applies an enactive approach can significantly improve student learning outcomes. Students who learn through direct experience tend to understand concepts more easily, are able to think critically, and are more confident in expressing their opinions. The enactive process can be used as an indicator of the success of science learning, particularly in efforts to improve the quality of learning outcomes and achieve optimal learning objectives (Ziliwu., 2022). Therefore, this study will discuss the importance of the enactive process through experiments in improving learning outcomes based on Bruner's theory.

METHODS

This study uses a literature review approach to systematically review scientific publications that discuss the importance of the enactive process through experiments in improving learning outcomes based on Bruner's theory, without involving experimental testing. Data collection was carried out by searching for articles in reputable scientific databases such as Google Scholar and ScienceDirect, taking into account the relevance of the topic, the recency of the publication, and the credibility of the source. Furthermore, the findings obtained were analyzed thematically by grouping the studies into aspects of the concept of the enactive process according to Bruner's theory, the implementation of experiments in learning, student involvement, and its impact on learning outcomes, so as to obtain an overview of the conceptual relationship and empirical findings regarding the important role of the enactive process in improving the quality and learning outcomes of students.

RESULTS & DISCUSSION

Implementation of the Enactive Process in Bruner's Theory

The enactive process in Bruner's theory emphasizes learning through the actions and direct experiences of students (Bruner, 2021). Jerome S. Bruner developed a theory of cognitive development which states that learning is an active process in which students construct their own knowledge through concrete experiences. This process involves three stages of enactive, iconic, and symbolic representation. The enactive stage is the initial stage where students understand concepts through direct manipulation of real objects and real experiences. The application of learning that uses Bruner's theory can enliven the learning atmosphere because students are actively involved in every teaching and learning process. A supportive learning atmosphere is one of the motivations for students to learn. Teachers must be able to accept students' ideas regardless of what they are while showing whether or not they are in line with the theory. Teachers must have a broad and deep mastery of the material so that they can be more flexible in accepting different ideas from students. The use of Bruner's theory can help students remember, understand, process, and express all their knowledge about a concept to be used in problem solving (Nurhayati et al., 2022).

1) *Forms of Enactive Process Implementation*

Based on various previous research and studies, Enactive Interaction in Support of Creative Learning is a systematic literature review that discusses various forms of learning that have enactive characteristics (interactive & sensorimotor) to support creative and active student learning. The findings state that methods that allow students to interact directly with the learning environment dynamically can increase students' understanding and creativity (Masula et al., 2023). The implementation of the enactive process is widely used in several learning situations. These activities serve as concrete experiences that form the basis for conceptual understanding before students enter the iconic and symbolic representation stage. This approach is in line with Bruner's theory, which states that learning will be more effective if students gain direct experience first (Bruner, 2021). One of the most common forms of implementing enactive processes in science learning is through the discovery learning model . This model allows students to discover science concepts independently through experiments, observations, and real exploration, rather than just passively receiving material. In studies at MIN 1 Bantul and SDIT Baik Bantul, the application of discovery learning showed that science learning became more student-centered, where students carried out the scientific process in stages, from initial perturbation to conclusion through direct interaction with science phenomena in the classroom (Lase & Ndruru, 2022).

The implementation of discovery learning in science education is also carried out by integrating local contexts, such as local snacks, which become the subject of students' scientific exploration. This approach not only encourages hands-on activities but also fosters the connection between students' daily experiences and the science concepts being studied. For example, through exploring the components or process of making local snacks, students are trained to observe, hypothesize, test, and analyze data, which are the essence of the enactive process (Tyas et al., 2020). Another form of enactive implementation in science learning is through the direct experiment method. This method places students as the main actors in scientific experiments, where students carry out the steps of observation, manipulation of variables, data recording, and drawing conclusions directly. The implementation of this experimental method has been proven to increase student learning activity in science/IPAS subjects because students are involved in the learning process physically and mentally, in accordance with Bruner's enactive principle (Diah, 2023).

The implementation of the enactive process in science education in schools is generally realized through discovery learning, contextual exploration of real-life phenomena, direct experiments, and learning with the support of interactive digital media. These activities encourage students to be physically and cognitively active, in line with Bruner's enactive principle of *learning by doing* or learning through direct experience. This implementation shows a shift from theoretical learning to contextual, active, and meaningful learning for students.

2) Student Responses and Engagement in the Enactive Process

The results of the study show that the learning process that implements enactive learning has a positive response. The positive response of students is also seen from their perception of the learning process, which is considered more interesting and meaningful. Research by Nabila & Setiawan (2025) states that student responses to enactive learning show positive to very positive categories, especially when methods such as discovery learning are applied in the context of Ethno STEM, which explicitly contains concrete activities, exploration, and knowledge seeking by students themselves. The average score of student responses to this learning shows a very good category, indicating that students feel interested, satisfied, and motivated to participate in the active learning process (Nabila & Setiawan, 2025). Behavioral involvement such as answering questions, asking questions, and conducting experiments directly are also clear indicators of student involvement in the enactive learning process. This supports Bruner's concept that active experiences with learning objects trigger deeper understanding (Lase & Ndruru, 2022)

In addition, the enactive process also increases the cognitive involvement of students. Through concrete activities, students are encouraged to think critically, ask questions, formulate hypotheses, and draw conclusions based on the results of their actions. This cognitive involvement shows that students do not simply perform activities mechanically, but also process information and build a deep understanding of concepts. Thus, the enactive process helps learners connect real experiences with the concepts being learned. Overall, learner responses and engagement in the enactive process cover three main aspects, namely affective (interest and motivation), behavioral (activity and participation), and cognitive (thinking processes and conceptual understanding). These three aspects are interrelated and contribute to the creation of meaningful learning. Therefore, the application of the enactive process is an important strategy for teachers to improve the quality of learning interactions and encourage the overall involvement of students in the learning process.

Thus, the implementation of the enactive process has proven to be effective in improving student response, engagement, and learning outcomes. These findings further reinforce Bruner's theory, which asserts that activity-based learning experiences are an important foundation for meaningful and sustainable learning.

Impact of the Implementation of the Enactive Process on Student Learning Outcomes

The application of the enactive process has a significant impact on student learning outcomes. This impact is not only seen in increased mastery of the material, but also in changes in the way students understand the learning process and the development of process skills that support meaningful learning.

1) *Changes in Understanding of the Learning Process*

The results of the study show that learning using the enactive process encourages changes in the way students understand concepts and the learning process. Students no longer view learning as a one-way activity of receiving information, but rather as an active process that requires involvement and direct experience (Arsyad et al., 2024). Through systematically designed activities, students can build their understanding of concepts gradually and contextually. In a recent research article, Bruner's theory is described as an approach that emphasizes this change in understanding, as seen in the ability of students to explain concepts in their own words and relate the learning material to their experiences during the activities and manipulation of real objects before entering the iconic and symbolic stages. This enactive stage is the initial basis for building conceptual understanding, as students directly experience and grasp the meaning of the material through concrete actions (Purnomo, 2022)

Recent empirical studies, such as quasi-experimental studies and classroom action research, confirm that Bruner's approach, which involves the enactive stage, significantly improves student learning outcomes. Learning outcomes, student engagement, and motivation in learning increase because learning activities are no longer limited to listening to the teacher's explanations but involve students directly in tasks and the manipulation of real objects (Gombo, 2024). Significant changes are also seen in the roles of teachers and students in the learning process. When the process is dominated by traditional (*teacher-centered*) theory, students are considered passive recipients of information. However, with the application of enactive learning, the role of the teacher shifts to that of a facilitator or guide, while students become the center of learning who actively explore and construct knowledge through real practice. This change in understanding strengthens students' cognitive engagement and expands their critical thinking skills in a contextual setting (Yusuf & Yeti, 2024).

2) *Improvement of Students' Process Skills*

In addition to impacting conceptual understanding, the implementation of the enactive process also contributes to the improvement of students' process skills. These process skills include the ability to observe, classify, communicate, collaborate, and solve problems that arise during learning activities.

Through direct involvement in various learning activities, students are trained to observe carefully, analyze the information obtained, and make decisions based on their learning experiences. Enactive learning encourages students to be directly involved in experiments, observations, and problem solving, so that they do not just memorize concepts but experience and construct these concepts themselves. This strengthens process skills such as observation, interpretation, and scientific communication (Annasihah & Mediasari).

Repeated scientific learning, such as experiments, data processing, and conclusions, provides space for students to repeatedly practice scientific skills, which are important competencies in science. This approach reinforces meaningful and sustainable learning in accordance with Bruner's theoretical foundation (Sya et al., 2022). In enactive learning, teachers also play a role in providing practical experiences, compiling real problems, and giving feedback that guides students' development, so that students actively think and act in the learning process directly (Putri et al., 2024). Thus, students can think critically and creatively because they must use real data to draw conclusions in direct practical activities.

The Relationship Between the Implementation of the Enactive Process and Bruner's Theory

The implementation of the enactive process in learning shows a strong connection with Bruner's learning theory (Bruner, 2021). Various previous research findings confirm that learning with the enactive process can facilitate students in building conceptual understanding through direct experience before entering a more abstract representation stage.

1) *Research Findings Consistent with the Stages of the Enactive Process*

Several studies reveal that student involvement in direct learning activities is a key characteristic of the enactive stage as described by Bruner. Handiyati et al. (2023) reveal that activity-based learning encourages students to build initial understanding through concrete actions, such as observing, trying, and manipulating learning objects. These findings indicate that students find it easier to understand concepts when they first experience the learning process concretely. The enactive stage in Bruner's learning theory has been proven to play an important role in improving students' process skills and conceptual understanding. Learning that begins with concrete activities such as manipulating real objects and direct experiments makes students more active in constructing their knowledge (Safari & Inayah, 2024).

Furthermore, Dwi & Yahya (2025) found that the application of direct learning activities had a positive impact on students' ability to relate learning experiences to theoretical concepts. These findings indicate that the enactive stage plays an important role as a foundation in the process of knowledge representation as described in Bruner's theory. Other findings also confirm that the enactive stage is an important foundation before students enter the iconic and symbolic stages in the learning process (Gombo, 2024).

2) *The Role of Exploratory and Experimental Activities in Building Student Representations*

Within Bruner's theoretical framework, experiences at the enactive stage serve to build learners' initial representations of the concepts being studied. Winarsih (2025) reveals that exploratory activities, including simple trial and error activities, play an important role in helping learners form initial mental representations before understanding concepts in visual or symbolic form. Another. study by Nurlaela (2023) shows that experiments packaged in learning activities do not always have to be formal experiments, but can take the form of exploration and manipulation of learning objects. These findings confirm that experiments serve as a means for learners to construct meaning through action, which in turn facilitates the transition to the iconic and symbolic stages.

In addition, Ristiani et al. (2025) concluded that enactive experiences through simple activities and experiments help students develop stronger and more lasting conceptual representations. These representations form the basis for learners in understanding symbols, terms, and abstract concepts introduced in subsequent stages of learning. This is in line with Bruner's theory, which emphasizes that the learning process occurs gradually through enactive, iconic, and symbolic representations.

Contribution to the Development of Learning Theory and Implications for Teachers

The implementation of the enactive process not only has an impact on improving student learning outcomes, but also makes an important contribution to the development of learning theory, particularly the cognitive-constructivist theory proposed by Bruner. The findings in this study reinforce the relevance of Bruner's theory in the context of contemporary learning, which demands the active involvement of students.

1) *Contribution to the Development of Learning Theory*

Theoretically, the findings discussed show that the enactive process still plays a central role in modern learning. The enactive process can reinforce the constructivist paradigm and learner-centered learning, namely by learning that begins with concrete actions and manipulation of real media, emphasizing the position of learning as the active construction of knowledge by learners, not a one way transfer of information. This enriches modern learning theory by placing sensorimotor experiences as the basis for cognitive development and conceptual understanding (Rahmania et al., 2025). In addition, this study confirms that the enactive process is not only understood as the initial stage of learning but as a dynamic foundation that continues to influence the process of iconic and symbolic representation. Thus, it contributes to strengthening constructivist learning theory, which places learners as builders of knowledge through experience and reduces misconceptions when students encounter abstract material. These findings reinforce Bruner's stage structure as a practical theoretical framework (Agustin & Pratini, 2025).

The enactive principle is the conceptual basis for many applied learning models, such as Discovery Learning, Guided Inquiry, and Project-Based Learning, which have been tested in classroom action studies and quasi-experiments. The results show consistency between theory and practice. Thus, enactive learning is not only theoretical but also has a strong empirical basis (Purwanti & Rohmah, 2024). The concept of enactive learning can redefine the role of failure/incorrectness in the learning process. Within the enactive framework, mistakes are viewed as experimental data that help revise understanding, shifting from outcome-based evaluation to more reflective process assessment. Classroom action research findings support that a classroom environment that is safe for experimentation increases tolerance for error and encourages deep learning (Nadya et al., 2024).

2) *Implications and Recommendations for Teachers in Implementing the Enactive Process*

Based on the results and discussion, teachers are advised to consciously and deliberately integrate the enactive process into their teaching. Teachers need to design activities that allow students to be directly involved, experience the learning process, and reflect on that experience so that learning becomes more meaningful.

Teachers are also advised not to immediately emphasize the delivery of concepts in the form of symbols or abstract definitions, but to provide space for students to build understanding through concrete experiences first. The activities designed should be tailored to the characteristics of the material, learning objectives, and student abilities (Riska et al., 2023). In addition, teachers play an important role as facilitators who guide students in connecting their learning experiences with the concepts being studied. Reflection and discussion need to be optimized so that students can construct meaning from the activities carried out. Thus, the enactive process is not only a physical activity, but also a deep cognitive process (Nadya et al., 2024).

In conclusion, the implementation of the enactive process based on Bruner's theory can be a relevant and sustainable learning strategy. Teachers are expected to be able to adapt this approach creatively so that learning is not only oriented towards the final result but also towards the process of forming meaningful knowledge.

CONCLUSION

Based on the results of the discussion, it can be concluded that the enactive process is very important in science learning because it is able to create meaningful learning through the direct involvement of students in experimental activities. The application of the enactive process has been proven to increase student activity, enthusiasm, and involvement during learning, so that students do not only receive information passively but build conceptual understanding through real experiences. The impact is seen in the improvement of student learning outcomes, both in terms of conceptual understanding and scientific process skills, such as observing, reasoning, and concluding. Thus, the enactive process contributes significantly to improving the quality of science learning and student learning outcomes as a whole.

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