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Application of Edu Assembly Media to Improve Understanding of Joint Material Concepts for Grade VI Elementary School Students

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Conceptual understanding of joints in IPAS learning remains a problem because the material is abstract in nature and requires spatial visualization skills. The initial learning conditions in Grade VI at SD Negeri Muktiharjo Kidul 02 showed that students experienced difficulties in understanding the types, locations, and directions of joint movements due to teacher-centered learning and the use of less interactive two-dimensional visual media. This study aimed to improve students' conceptual understanding of joints through the implementation of Assemblr Edu 3D media. The study employed Classroom Action Research (CAR) based on the Kemmis and McTaggart model, which was conducted in two cycles, with each cycle consisting of planning, action, observation, and reflection stages. The research subjects were 26 Grade VI students. Data were collected through conceptual understanding tests and observations of learning activities and were then analyzed quantitatively and qualitatively. Conceptual understanding was measured through the indicators of interpreting, classifying, explaining, and comparing. The results showed an improvement in students' conceptual understanding. The percentage of classical mastery increased from 19.23% in the pre-action stage to 53.84% in Cycle I and 88.46% in Cycle II. In Cycle II, all conceptual understanding indicators also achieved results above the target, namely interpreting at 86%, classifying at 90%, explaining at 84%, and comparing at 88%. The implementation of Assemblr Edu also improved student activity and teacher performance to the very good category. Therefore, Assemblr Edu 3D media is effective in improving students' conceptual understanding of joints in Grade VI elementary school.
Keywords: Assemblr Edu, conceptual understanding, joints

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1. Introduction

Understanding concepts in Natural and Social Sciences (IPAS) is a very fundamental cognitive achievement for students at the elementary school level (Nasriyanti et al., 2021). In the current era of global development, the orientation of learning in science has fundamentally transformed from the mastery of memorizing textual facts to the formation of a deep and meaningful understanding of concepts. Concept comprehension is defined as the ability to understand and absorb information from visual and auditory experiences to be stored in long-term memory, which is shown through the ability of students to describe material using their own language, classify objects, and apply them in solving problems of daily life (Lestari et al., 2024). Understanding the concept according to Anderson & Krathwohl in (Suryani, 2018) According to the revised Bloom taxonomy which consists of seven indicators, namely explaining, interpreting, drawing inferences, providing examples, summarizing, classifying, and comparing. Therefore, the success of achieving an optimal understanding of concepts in science learning is highly determined by the teacher's ability to package subject matter so that it is easy to understand, interesting, and able to trigger students' active involvement in the entire learning process in the classroom.

However, in practice in the field, the science learning process often faces serious obstacles related to the characteristics of some abstract subject matter. One of the materials that has a high level of visual complexity is the material on the movement system in humans, especially the sub-material of mechanics and types of joints (Nurhasanah et al., 2026). Ideally, learning in this material requires students to be able to understand the hidden anatomical components of the inner body and visualize how the direction of spatial motion is produced by each joint. To achieve this understanding in its entirety, students urgently need the help of representative, concrete, and dynamic visual learning media so as not to experience confusion or misconception in distinguishing characteristics and functions between joints.

The main key to bridging the gap between abstract material characteristics and students' conceptual understanding needs is the use of interactive three-dimensional (3D) technology through the media of Assemblr Edu (Rahmawati & Usamah, 2024). Edu Assemblr Media has the advantage of projecting dynamic 3D objects regarding joint anatomy into the classroom in a realistic way real-time. Through this media, students can interact directly by twisting, enlarging, and observing the mechanism of joint work from various precise perspectives. The integration of Assemblr Edu's interactive technology is very much in line with Ki Hadjar Dewantara's educational philosophy, especially regarding the principle of "Nature of the Times". Ki Hadjar Dewantara emphasized that the teaching process must continue to develop according to the demands of the times and the natural nature of students (Novianti & Nisa, 2023). The students in the current era are the generation Digital Natives who are born, grow up and interact closely with visual technology and information networks (Hadi et al., 2025). Applying Assemblr Edu 3D media in the classroom is a real form of independent and contextual teaching, where technology is used positively to change the learning experience to be more interactive and meaningful. The potential success of this media is strengthened by previous studies from Purwanti et al. (2025) and Pian et al. (2026) which proves that the use of Assemblr Edu is significantly effective in visualizing abstract materials and improving the understanding of IPAS concepts in elementary school students.

Although the potential of Assemblr Edu media is very promising, the reality of learning at SD Negeri Muktiharjo Kidul 02 shows a gap analysis. The understanding of the concept of grade VI students on joint materials is still very low. The results of initial observations and pre-action tests show that the majority of students have difficulty describing the type of joint, determining their location on the body, and demonstrating the direction of movement. This problem is rooted in a teacher-centered learning approach and the reliance on passive two-dimensional (2D) drawing media in textbooks and PowerPoint slides. Verbal learning without dynamic visual stimulation makes students feel bored, passive, and have difficulty imagining the mechanical work of the joints. The limitations of technological facilities in schools, where only 1 unit of teacher's laptop is available without individual student gadgets, further widens the gap between the demands of modern learning and the real conditions in the classroom.

The novelty value of this study lies in the integration of Assemblr Edu interactive 3D media which is specifically designed to overcome abstract misconceptions of joint material in grade VI elementary school students, as well as manifesting the principle of the Nature of the Age of Ki Hadjar Dewantara in classroom improvement actions. Based on these gaps, this study aims to test and describe the application of Assemblr Edu media in improving understanding of the concept of joint material in grade VI students of SD Negeri Muktiharjo Kidul 02.

2. Research Methods

This research is a Class Action Research (PTK) which is carried out in two cycles referring to the Kemmis and McTaggart models, where each cycle includes four stages: planning, implementation of actions,

observation, and reflection. The research was conducted in the odd semester of the 2026/2027 school year at SD Negeri Muktiharjo Kidul 02. The research subjects consisted of 26 grade VI students (12 boys and 14 girls) who experienced problems understanding concepts in joint materials.

The action implemented was 3D technology-based science learning using Assemblr Edu media. In the planning stage, the researcher compiled a teaching module, 3D visual material for joints in the Assemblr Edu application, as well as assessment instruments. In the implementation and observation stages, students explored 3D models of joints interactively (twisting, enlarging, and observing the mechanism of joint movement), while observers observed student learning activities and teacher performance.

The research data was collected through two techniques, namely (1) concept comprehension test, the indicators of concept understanding used in this study are interpreting, classifying, explaining, and comparing. (2) observation, using a structured observation sheet in the form of *a checklist* to observe the implementation of learning activities based on Assemblr Edu, both in terms of teacher performance and active student participation.

The data analysis technique used combines quantitative and qualitative analysis. Quantitative data is processed from the results of the students' concept understanding test to calculate the percentage of individual learning completeness based on the KKTP () score and classical completeness, which is declared successful if at least 82% of students achieve the grade. Meanwhile, qualitative data is processed from observation sheets to assess the implementation of student learning activities and teacher performance which is converted into the categories of Very Good (), Good (), Sufficient (), and Less (), with the criteria for success reaching the minimum category of Good ().$\geq 78 \geq 7881 - 100\%66 - 80\%51 - 65\% \leq 50\% \geq 66\%$

3. Results And Discussion

Results

This Class Action Research (PTK) was carried out in two cycles for grade VI students of SD Negeri Muktiharjo Kidul 02 to improve their understanding of the concept of joint material through the use of 3D *Augmented Reality* Assemblr Edu media. Each cycle is carried out through four main stages, namely *planning*, acting, *observing*, and *reflecting*.

In the pre-cycle condition (initial condition), science learning of joint materials is still carried out conventionally using passive 2D drawing media from textbooks. Initial observations show that most students have difficulty understanding the direction of motion and joint shape spatially, thus having an impact on the low achievement of KKTP. Based on this problem, corrective actions are designed through PTK.

In the planning stage of Cycle I, the researcher compiled the IPAS Teaching Module of joint material, prepared 1 unit of the teacher's laptop with the Assemblr Edu application installed, and prepared an assessment instrument. In the implementation stage, the teacher divided the students into several groups. Learning was carried out by each group taking turns advancing to the teacher's desk to try and rotate the joint 3D object directly on 1 laptop, while the other group worked on the worksheet in writing on their respective desks without media display. Based on the observation stage, this turn flow triggered time inefficiency. The group waiting for their turn tended to lack focus and experienced confusion because they did not see the simulation of the 3D object being operated on the teacher's desk. The results of the reflection of Cycle I show the need to improve the scenario: the teacher's laptop must be connected to a projector (*LCD Projector*) so that all students can listen to the display of the 3D object together first.

In the planning stage of Cycle II, the researcher redesigned the learning scenario by integrating a projector connected to 1 teacher's laptop. In the implementation stage, the teacher opened the learning by displaying a 3D object of the Assemblr Edu joint on the projector screen in front of the classroom. The teacher explained the concept of movement direction and joint shape in a classical way, then called several student representatives to the front to try to play a simulation of a 3D object on a laptop highlighted by the projector. After the initial understanding was formed evenly throughout the class, each group took turns advancing to the teacher's laptop to conduct independent confirmation and exploration. The observation stage showed that the learning atmosphere became much more conducive, interactive, and directed. The results of the reflection of Cycle II confirmed that the viewing of the classical projector from 1 teacher's laptop succeeded in overcoming the limitations of technological facilities, minimizing time management constraints, and boosting the completeness of student learning optimally. The dynamics of differences in the learning process between cycles are presented in Figure 1.

Figure 1. Documentation of Learning Implementation in Cycle I

Figure 2. Documentation of Learning Implementation in Cycle II

The measurement of understanding of the concept of joint matter was carried out through tests on pre-action (pre-action), Cycle I, and Cycle II. It was measured through 4 indicators, namely interpreting, classifying, explaining, and comparing. The comparison of the percentage gain of each indicator from Cycle I to Cycle II is described as follows:

Interpreting

Interpreting indicators are measured through questions that ask students to translate visual stimuli of body movements and daily context into joint type concepts and determine preventive measures for joint disorders. In the Precycle, students have difficulty interpreting 2D images in textbooks. The application of Assemblr Edu in Cycle I began to help students' visual representation, and the improvement of projector impressions in Cycle II enabled students to interpret the mechanics of joint movement with precision.

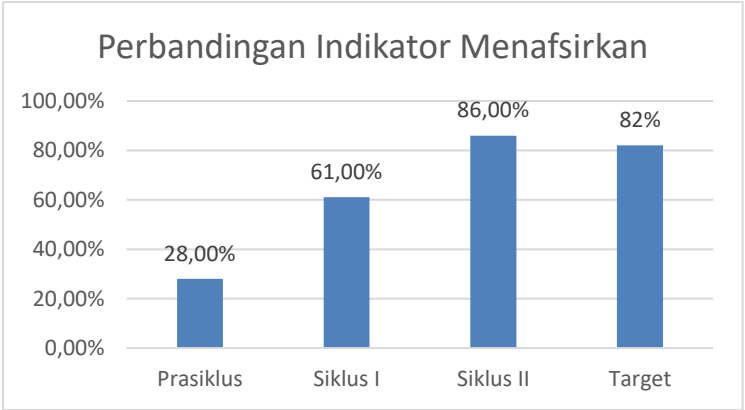

Figure 3. Interpreting Indicator Comparison Chart

Based on Figure 2, the achievement of interpreting indicators has increased consistently from Pre-Cycle (28%), Cycle I (61%), to Cycle II (86%). There is an increase of 58% from the initial condition to Cycle II, which indicates that students have been able to translate the visualization of images and body movement phenomena into the concept of joint type appropriately.

Classifying

The classification indicator is measured through questions that ask students to group body movements, match tables of body parts, and choose joint care actions. In the Precycle, students are often confused in grouping joint types. After the intervention of the 3D Assemblr Edu media, the ability to categorize the variation of students' daily activities increased rapidly.

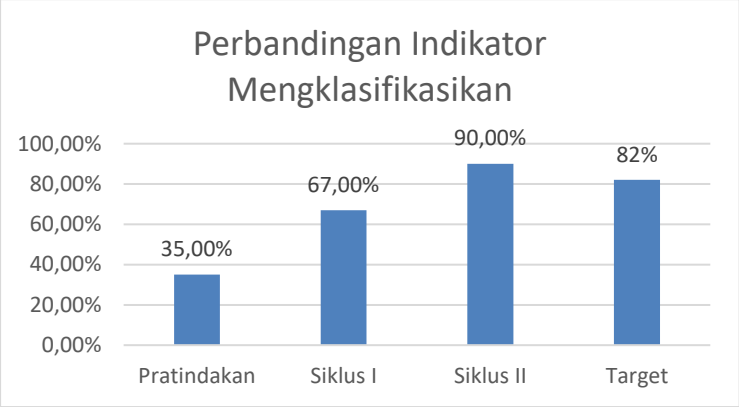

Figure 4. Classification Indicator Comparison Diagram

Based on Figure 3, the gains in the classification indicator increased from Pre-Cycle (35%) to Cycle I (67%), and reached 90% in Cycle II. This cumulative increase of 55% shows that the exploration of 3D objects makes it easier for students to categorize body parts and directions of motion into appropriate joint types.

Explaining

The explained indicator is measured through questions that ask students to explain the definition of joints, the function of sliding joints when bending, the flow of joint mechanics in sports, and scientific reasons for maintaining joint health. The limitations of students' explanations in the Precycle due to verbal learning were successfully overcome through a dynamic simulation of Assemblr Edu.

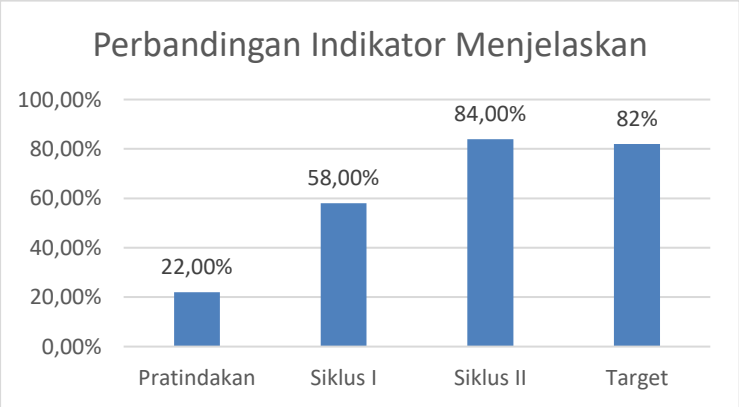

Figure 5. Indicator Comparison Diagram Explains

Based on Figure 4, the results obtained in the indicator show a significant upward trend from Precycle (22%), Cycle I (58%), to Cycle II (84%). This 62% increase proves that students are now able to decipher definitions, mechanical functions, and causal relationships related to the role of joints using their own language.

Comparing

Comparative indicators are measured through questions that ask students to analyze and differentiate the freedom of motion between the shoulder joint and the knee joint. The students' conceptual understanding of the difference in joint motion develops rapidly after seeing a 3D rotation simulation directly.

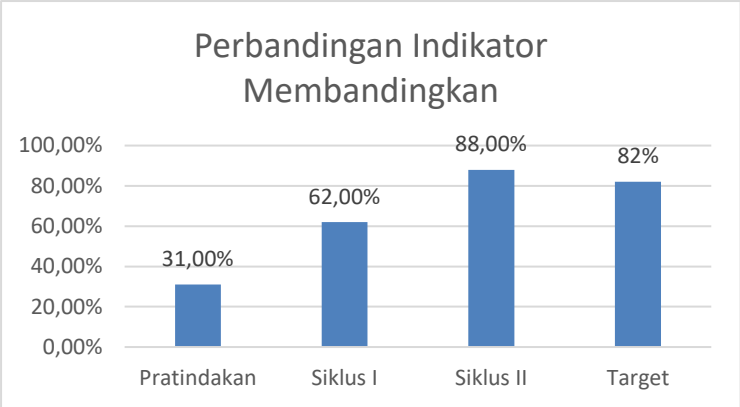

Figure 6. Comparison Indicator Comparison Chart

Based on Figure 5, the achievement of the comparative indicator increased from 31% in the Pre-Cycle to 62% in the First Cycle, and reached 88% in the Second Cycle. This data confirms that the students have been able to accurately detect and distinguish the level of freedom of movement between types of joints.

The measurement of overall concept understanding of joint matter was carried out through tests in pre-action (pre-action), Cycle I, and Cycle II. A comparison of the completeness of concept understanding is presented in Table 1 and a visualization of its development is shown in Figure 6.

Table 1. Comparison of the Completeness of Students' Concept Understanding

Evaluation Stage	Average Score	Number of Students Completed	Classical Completeness Percentage	Completeness Category
Pre-Action (*Pretest*)	64,04	5	19,23%	Very Low
Cycle I (*Posttest* 1)	76,73	13	50,00%	Incomplete
Cycle II (*Posttest* 2)	87,50	23	88,46%	Classical Finish

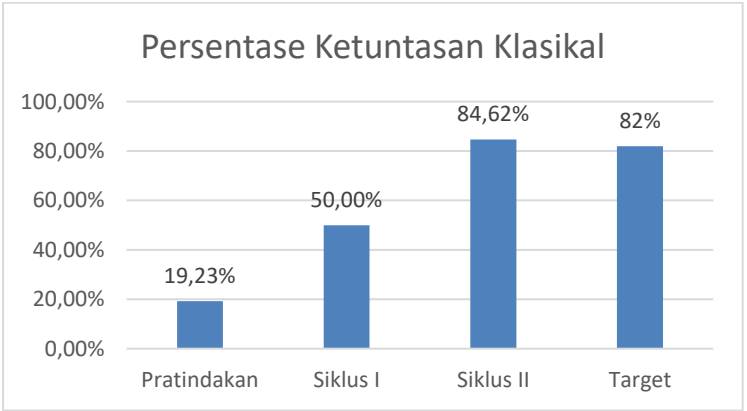

Figure 7. Graph of Percentage of Classical Completeness of Students' Concept Understanding

Based on Table 1 and Figure 6, the pre-cycle conditions show that concept understanding is very limited because most students have not reached the KKTP limit (). The application of Assemblr Edu in Cycle I was able to significantly increase the average class and achievement of student completeness, but this achievement did not meet the research success criteria set at 82%. The improvement of actions in Cycle II which focused on integrating projector screens from 1 teacher's laptop succeeded in boosting concept understanding to the maximum to exceed the classical success indicator at the end of Cycle II (reaching 84.62%).≥ 78

The implementation of actions and class dynamics was recorded by observers using a structured observation sheet. A recapitulation of the development of the percentage of activity implementation is presented in Table 2.

Table 2. Recapitulation of the Implementation of Student Activities and Teacher Performance

Observation Aspect	Percentage of Cycle I	Category Cycle I	Cycle II Percentage	Category Cycle II
Student Learning Activities	67,31%	Good	86,54%	Excellent
Teacher Performance	73,08%	Good	90,38%	Excellent

Table 2 shows positive developments during the learning process. In Cycle I, student involvement in exploring Assemblr Edu's 3D media and teachers' performance in facilitating classes was in the good category, although it was colored by time management constraints due to queues in 1 laptop. In Cycle II, the implementation of student activities and teacher performance increased rapidly to reach the very good category as the classical projector demonstration was implemented.

Discussion

The classroom action research (PTK) carried out in grade VI of SD Negeri Muktiharjo Kidul 02 aims to solve real problems in learning, namely the low understanding of the concept of science in joint materials and their direction of motion, through the use of 3D visual media Assemblr Edu. This research is designed and carried out continuously in two cycles, where each cycle includes four main stages: planning (*Planning*), implementation (*Acting*), observation (*Observing*), and reflection (*Reflection*) (Arikunto et al., 2021). The main data of the study focused on the achievement of students' concept understanding as measured through an evaluation test (*Posttest*) at the end of each cycle. The evaluation test is designed to measure four indicators of concept understanding based on taxonomic thinking, namely: interpreting (*interpreting*), classify (*Classifying*), explain (*Explaining*), and compare (*Comparing*). To gain a comprehensive understanding of classroom dynamics, the researcher also collected supporting qualitative and quantitative data in the form of observation sheets of researcher activities (teacher performance) and observation sheets of student activities during the action.

Novelty (*novelty*) of this study lies in the integration strategy of 3D visual media Assemblr Edu to visualize the mechanics of anatomical movement of the human body in the Independent Curriculum at the elementary school level. In the tracing of previous studies, the use of 3D media and Augmented Reality (AR) based on Assemblr Edu for specific topics understanding the concept of joint mechanics is still very limited (Fitriannor et al., 2024; Lailaningrum & Rindrayani, 2025).

In the pre-action (pre-cycle) stage, the researcher analyzes the initial conditions through direct observation and Pre-test in grade VI of SD Negeri Muktiharjo Kidul 02. The results of the observation showed that students experienced significant difficulties in mastering the concept of IPAS, especially on topics involving the spatial representation of complex body anatomy such as the skeletal and joint system (Tansha & Siregar, 2026). Understanding basic concepts is the cognitive ability of students to absorb, internalize, and

represent an idea or scientific idea appropriately without changing its true meaning (Meidianti et al., 2022). Mastery of concept understanding is the main focus in science learning because it determines students' reasoning ability at the next level (As Sa'adah et al., 2025). In the pre-cycle, the average grade of students was still far below the Learning Goal Achievement Criteria (KKTP = 78). The root cause of this problem is the delivery of material by teachers which is still conventional, abstract, and dominates learning through verbal explanations and two-dimensional texts from textbooks (Maghfiroh, 2026; Sari et al., 2023). This passive and monotonous learning has been proven to hinder the absorption of information deeply and cause a sense of boredom in students (Tansha & Siregar, 2026). This is in line with the view (Akollo et al., 2020) that a fun and interactive learning climate is indispensable to arouse active student involvement, where students who are actively involved in learning activities will experience a significant escalation in material understanding (Rahim & Dwiprabowo, 2020).

Science subjects in the Independent Curriculum at the elementary school level hold a key position to train science process skills, curiosity, and logical reasoning (Abdullah et al., 2025). Learning motion system material should not stop at memorizing the names or locations of joints, but must lead students to a deep understanding of how joint components work to facilitate body movement. Therefore, the application of digital-based media such as 3D Assemblr Edu is a very appropriate pedagogical intervention. The Assemblr Edu 3D platform is able to transform anatomical objects that were originally abstract and hidden in the body into a dynamic, real, and flexibly interactable three-dimensional visual representation (Mulyani & Suryaman, 2025).

Grade VI elementary school students are in the transition of cognitive development from the concrete operational stage to the initial abstract operation (Phase C) according to Piaget's developmental theory, so they still need concrete visual bridges to understand systematic concepts that are not directly visible to the eye (Aisyah et al., 2025; Hidayah et al., 2025). In addition, the psychological characteristics of grade VI students who tend to favor animated exploration, technology-based novelties, and collaborative learning must be appropriately accommodated by educators (Sabani, 2019). The presence of clear 3D objects helps students construct a picture of joint mechanics in the human body (Nadifah et al., 2026). This strategy presents a meaningful science learning experience (Meaningful learning) and relevant to the daily lives of students (Nabilla et al., 2025). The implementation of digital-based learning is also in line with Ki Hadjar Dewantara's educational philosophy, where educators should guide students in accordance with the nature of nature (the development stage of children's age) and the nature of the times (the use of digital technology in the modern era) to bring abstract concepts of science closer to the scope of their real lives (Anggriani et al., 2025).

The integration of Assemblr Edu's 3D media has been proven to be able to stimulate and hone four indicators of students' concept understanding gradually and systematically (Fatma et al., 2025). Through 3D object manipulation features (such as rotating a 360-degree model, enlarging/*Zoom* joint parts, and observing motion animation simulations), students are helped to:

1. Interpreting: Translate 3D animation visualizations into a precise understanding of shapes and motion mechanisms.
2. *Classifying*: Classifying the types of joints (such as hinge, bullet, swivel, saddle, and slide joints) based on the physical characteristics of their location and direction of motion.
3. Explaining: Re-articulating the scientific reasons why a joint can only move in a certain direction using their own sentences in a systematic manner.
4. Comparing: Analyzing differences and similarities in characteristics and levels of freedom of movement between joint types in the body.

In the implementation of Cycle I, researchers have implemented Assemblr Edu 3D media in learning IPAS. However, in this initial cycle, the observation of 3D objects was still focused on the researcher's laptop screen at the front desk of the classroom where groups of students were asked to take turns progressing. The limited size of the laptop screen made the visual visibility of students sitting in the back very limited. As a result, the group waiting for their turn to advance became unfocused, lost attention, and triggered noise in the classroom. The condition of the poorly managed learning environment in Cycle I had a direct impact on the non-optimal achievement of student concept understanding indicators (Rohmaniah et al., 2025). Evaluation data in Cycle I showed that the average grade of the new class reached 76.53 with a classical completion percentage of 53.84% (only 14 out of 26 students completed the KKTP). Judging from the achievement per concept understanding indicator in Cycle I, the results of interpreting indicators were 61%, classifying 67%, explaining 58%, and comparing 62%. Meanwhile, the student activity observation score in Cycle I was only 67.31% (Good category).

Following up on the results of reflection and discussion with observers in Cycle I, the researcher designed action improvements in Cycle II. The key step is to change the mode of viewing Assemblr Edu 3D media from being originally limited to laptop screens to full classical viewing using LCD projectors in front of the class. Through this technique improvement, all students from each group can observe the details of 3D visualization and joint movement animation simultaneously, clearly, and brightly directly from their respective group desks without the need to stand or queue. The optimization of this classical visual means directly creates an orderly, calm, and conducive classroom atmosphere. Safe and orderly physical and psychological classroom conditions are essential. Effective classroom management by teachers is the main prerequisite for focusing students' attention and maximizing the success of the process of forming concept understanding (Hanipah et al., 2022).

The implementation of actions in Cycle II resulted in a very significant improvement, both in the quality of the learning process and student achievement. The observation results showed that the percentage of researcher activities (teacher performance) increased sharply to 90.38% (Very Good category), which reflects the flexibility of teachers in facilitating digital media and leading group discussions. In line with that, the percentage of student activity jumped rapidly to 86.54% (Very Good category), marked by the high enthusiasm of students when discussing dissecting LKPD and presenting the results of their visual observations.

The improvement in the process is directly proportional to the increase in students' conceptual understanding. The average score of *the class posttest* in Cycle II shot up to 87.5 with a percentage of classical completeness reaching 88.46% (as many as 23 out of 26 students successfully completed the KKTP). This increase occurred equally in all indicators of concept understanding in Cycle II:

1. Interpreting Indicators: Increased rapidly to 86% (up 25% from Cycle I). Pupils were able to interpret 3D visualizations precisely, such as interpreting how the positions of the elbow and knee bones work when performing bending and straightening movements in daily sports activities.
2. Classification Indicators: Increased in height to reach 90% (up 23% from Cycle I). Students became very careful and fast in grouping types of joints.
3. Indicator Explains: Experienced the highest increase from 58% in Cycle I to 84% in Cycle II (up 26%). Students no longer just memorize words from books, but are able to decipher scientific reasons and the workflow of joint mechanisms.
4. Comparing Indicators: A rapid increase of 88% (up 26% from Cycle I). Students have analytical acuity to compare the level of freedom of movement between joints, for example distinguishing in depth why the bullet joint on the shoulder has a direction of motion in all directions (360 degrees) while the hinge joint on the knee is limited to only one-way movement.

The success of increasing the understanding of the concept of IPAS in grade VI students of SD Negeri Muktiharjo Kidul 02 proves that the Assemblr Edu 3D media is a very effective learning formulation. Because the achievement of classical completeness in Cycle II has exceeded the indicators of the success of the actions set, this learning improvement was declared successful and the class action research was stopped in Cycle II. Overall, it can be concluded that the use of Assemblr Edu 3D media has proven to be effective in improving the understanding of the concept of IPAS for elementary school students.

4. Conclusion

The use of 3D *media Assemblr Edu* has proven to be able to overcome the main obstacle in learning science science in elementary schools, namely the high abstraction of the concept of human body anatomy, especially joints. The initial problem in the form of low conceptual understanding due to conventional learning that tends to be passive and verbalistic has been successfully bridged through concrete and interactive three-dimensional spatial visualization. This technological integration facilitates the cognitive transition of grade VI (Phase C) students from the concrete operational stage to the initial abstract, so that the learning process is no longer oriented to memorize mere anatomical terms, but to reconstruct a complete and contextual understanding of concepts.

The key to the success of this action lies in the classical optimization of Assemblr Edu's media viewing mode. The shift of visualization from the small device screen to the main projector LCD screen has been proven to not only expand the visual range of all students simultaneously, but also transform classroom management to be more orderly, focused, and conducive. This effective learning atmosphere triggers the dynamics of active group discussions, which ultimately encourages the mastery of four indicators of concept understanding in a balanced manner, ranging from the ability to interpret, classify, describe, and analyze.

The results of this study open up opportunities for the development of further research to test the effect of 3D visualization of Assemblr Edu on *long-term memory retention* through *delayed posttests*. Researchers can also combine this visual impression with supporting instruments such as interactive question cards to further trigger metacognitive abilities and depth of discussion between students in the group.

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