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EFFECTIVENESS OF AQUAPARTBOX NATURAL SCIENCE IIC TO IMPROVE LEARNING OUTCOMES IN SUBSTANCE AND PARTICLE MODEL SUB MATERIAL

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ABSTRACT

Science learning involves practicum to solve students' daily problems. Through needs analysis, it was found that only 15 percent of students had ever done practicum because of limited equipment. Due to this condition, students could not understand the phenomenon of natural science. Therefore, the purpose of the research 1) to design a tool for laboratory work, AquapartBox IIC (Integrated Instrument Component) (2) to measure the chances of student achievement with interaction of AquapartBox IIC. IIC was developed using the ADDIE model development research method (Analyze, Design, Development, Implementation, and Evaluation). Based on the analysis, there is potential for developing natural science IIC instructional media. At the design stage, a sketch was produced which became the basis for the development of the IIC. At the development stage, the AquapartBox IIC and learning tools were validated and tested. The validators consist of a biology lecturer, a physics lecturer and a science teacher. At this stage students are given a pre-test and post-test. The pretest score obtained was 80.14 and the posttest score obtained was 87.6. This second value is included in calculating the NGain calculation, the N-Gain obtained is 0.38. Next, a final evaluation was carried out by teachers (4.15) and students (3.89) which showed that IIC was effective. The impact of this study shows that the implementation of AquapartBox IIC improves student learning outcomes.

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1. INTRODUCTION

Natural science aims to provide a meaningful learning experience for students. Natural science learning directs students to master the concepts of natural phenomena. which is close to students' daily lives and prioritizes scientific approaches and ways of thinking (Kanga *et al*., 2022; Astalini & Kurniawan, 2019) as well as training to solve problems systematically. Learning with a scientific approach in science can be done through practicums to solve everyday problems. Regarding Arini & Darmayanti (2022), practicum is a learning activity that involves students using tools and materials to gain direct experience with a scientific approach. the obstacles to implementing practicum in schools are limited equipment and availability of materials (Marcella *et al*., 2018). Therefore, solution are needed to overcome obstacles in practicum so that students obtain optimal benefits.

According to Sukarjita (2020) & Sanulita *et al*. (2024), IIC (Integrated Instrument Component) is a learning medium which can be in the form of a collection of teaching aids or a set of practical tools. IIC as a set of practical tools is made concisely. The materials for making IICs are cheaper than the price of practical tools that are sold in general and are easy to use (Izzania & Widhihastuti, 2020; Triswidiyanto *et al*, 2024). This shows that IIC is a solution to the problem of limited tools and materials for practicum. One example of the development of science IIC learning media was carried out by Subamia & Nurfianti *et al*. (2015), who developed a IIC in the form of a prototype to support practicums on environmentally oriented substance materials and changes by selecting tools and materials using used materials. The development of the Science IIC, apart from being aimed at mastering material, can also be integrated to solve environmental problems. This is in line with the opinion of Tapilouw *et al*. (2017), namely that junior high school students learn to solve environmental problems through science learning.

Environmental issues such as water pollution can be integrated into science education, particularly through practicum. Unsafe drinking water sources are an environmental problem that must be addressed. One of the technologies used in water treatment to improve its quality is the Water Purifier. This technology has been applied by Naftalina *et al.* (2021), to improve water quality so that it can be used safely by the community. Water filtration technology improves water quality by removing color and odor. Filtration is one of the stages in Water Purifier technology in the form of separating water from solid pollutant particles using a filter device (Akbar *et al*., 2021; Arum *et al*., 2024). The principle of separating substances based on particle size has the potential to be developed in natural science learning that is integrated with concern for the environment. Therefore, technology is needed to improve and maintain water quality so that it is suitable for consumption and daily needs.

Based on research conducted by Bahtiar *et al*. (2022), there was a lack of students' knowledge about pollutants of various sizes, this research suggested linking this concept in learning. The biological aspect of this problem is water pollution in people's drinking water which is dangerous for health (Nabila *et al.*, 2023). The physical aspect of this problem is water pollution in solid state. These pollutants cause water to become colored and odor, these substances consist of materials of various sizes (Kumala *et al*., 2019). Organic solid pollutants are divided into Dissolved Organic Matter (DOM) measuring ≤ 0.1 μm and Particulate Organic Matter (POM) measuring > 0.1 μm, DOM is in the form of colloids and materials that dissolve in water while POM is in the form of plankton, algae and insoluble organic materials water (Monroy *et al*., 2017). Inorganic plastic pollutants can be macroplastics measuring >5 mm, mesoplastics measuring 5-1 mm, and microplastics measuring >1 mm (Ziani *et al*., 2023). Therefore, to separate water from solid pollutants, filters of various sizes and several stages are needed.

One of the integrated natural science materials in Class 7 is substance and particle model. In this material, one of the sub-discussions, namely substance form and particle models, explains the differences in form between solid, liquid and gas (Rahmawati *et al*., 2017). This sub-discussion has the potential to be developed by integrating it with environmental topics. In this way, students can separate solids and liquids. The solid substances are represented by pollutant substances carried along with the water. Based on this explanation, material can be used to simulate the separation of polluted water based on the size of the pollutant particles. The integration of the environment and sub-discussion forms and particle models is an attempt to create novelty in learning.

In the learning context, innovation means teaching and learning activities by presenting novelty or different from before (Nugroho, 2019; Pertiwi *et al.*, 2024). The process of adapting learning in current developments is carried out through innovation which aims to maintain and improve the quality of learning so that education develops (Permana, 2022; Bereki, 2022). Learning innovations can present in various forms such as learning models, learning media, or learning resources, which encourage students to be more active in learning (Susilo, 2020). Learning media functions to facilitate communication between teachers and students. Learning media innovations make communication more effective. Learning media Before Implementation, the innovative learning media goes through a trial process (Pribowo, 2018; Putri *et al*, 2021). The implementation of media innovation aims to increase students' knowledge as measured through Normalized-gain (Ramdhani *et al*., 2020; Jannah, & Shofiyah, 2024).

Based on the previous explanation about the research problem, IIC/ Integrated Instrument Component as learning innovations were potential to be carried out. A form of learning innovation is the development of a IIC on Substances and Particle model which was integrated with environmental studies, especially water pollution. Apart from science learning innovations, the research objectives of recent study are (1) Developing a science IIC on the sub-material of substances and particle models in class 7 of junior high school and (2) Knowing the effectiveness of the Science IIC on the sub-material of substances and particle models.

2. METHOD

The research method was research and development (R&D). The approach was ADDIE. According to Sugiyono (2019), ADDIE consists of the Analysis, Design, Development, Implementation and Evaluation as stages of product development. This learning media was implemented at the Junior High School level with the research subjects being two classes of 7th grade students. The time used in the research was during the 2024/2025 semester I, from August to December 2024.

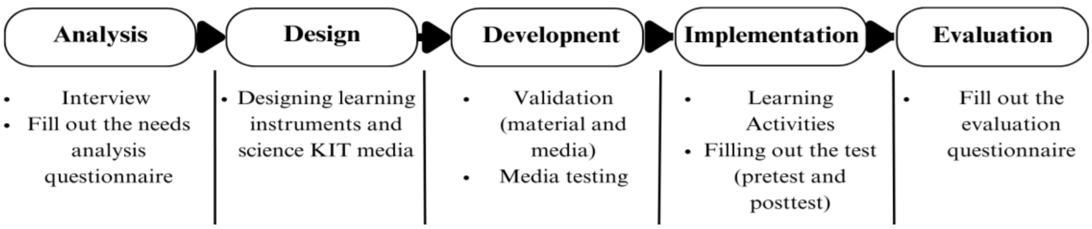

Figure 1. ADDIE Procedure

At the analysis stage, information is obtained through interviews and filling out questionnaires. (Figure 1). IIC and learning tools (teaching modules, student worksheet, and test questions) were designed at design stage. The IIC design began with making a IIC sketch which became a reference in selecting tools, materials and assembling the IIC. The development stage is the testing and revision stage of the product that has been designed. The development stage consists of validation of the AquapartBox IIC, validation of learning tools, and trials. The IIC and learning tool validation steps produce a product that has been revised based on experts' suggestions. Learning media and instruments are implemented for 4x40 minutes (4 lesson hours). The evaluation stage was carried out on students and teachers with the aim of measuring the effectiveness of the AquapartBox IIC.

Data collection uses instruments in the form of interview sheets, questionnaires, tests, and observation sheets for the implementation of lesson plans. Questions in the interview consisted of the science curriculum, media, Integrated Instrument Components (IIC), and materials that use IIC. The questionnaire is used as an instrument for analyzing student needs. Next, students are given tests before learning (pretest) and after learning (posttest). Both tests are conducted to determine students' knowledge before and after the implementation of learning. PBL (Preblem Based Learning) implementation sheet is filled in during IIC implementation. PBL is used in the Implementation of AquapartBox IIC because of its systematic system and helps students solve everyday problems.

The data analysis techniques were carried out in the form of numbers and processed using statistics, consisting of learning media validation, N-Gain, and learning media effectiveness. Software Microsoft Excel 2021® was used in statistical data analysis. Validation uses a Likert scale validation sheet with the conditions (1) very invalid; (2) less valid; (3) quite valid; (4) valid; and (5) very valid. The product is tested first on students before entering the implementation stage. The trial used a wide Likert scale trial instrument with the conditions (1) very indecent; (2) indecent; (3) quite decent; (4) decent; and (5) very decent. Evaluation uses a Likert scale evaluation sheet with the conditions (1) very ineffective; (2) less effective; (3) quite effective; (4) effective; (5) very effective.

3. RESULTS AND DISCUSSION

After conducting research based on the R&D research method, the research results were obtained in four stages.

3.1. Development of AquapartBox IIC

Analysis Stage

Needs analysis aims to identify problems in learning experienced by students. The needs analysis was carried out through interviews with teachers directly in June 2024. The interview sources were science teachers. The needs analysis was carried out through interviews with science teachers. The results of the interview showed that the school uses an merdeka curriculum, learning material and particle models in the school uses various learning media such as whiteboards, PowerPoint, and through learning videos. Science IIC learning media has been used at this school, but not on substances and particle models. In accordance with Rahmawati *et al*. (2017), one of the sub-discussions, namely the states of matter and particle models, explains the differences in properties between solid, liquid and gas. This material is included in the learning outcomes (CP) of phase D science subjects in the science understanding element in the form of identifying the properties and characteristics of substances (Kemendikbud, 2022). In line with Kanga *et al*. (2022); Astalini & Kurniawan (2019), science learning is adapted to everyday life phenomena.

Table 1. Analysis Of Student Needs

Indicator	Yes (%)	No (%)
IIC knowledge	10	90
Practical learning experience	15	85
Teachers use a variety of media	100	0
Using IIC	10	90

n=28

The aim of the questionnaire was to obtain student information regarding IIC, practicum and learning media. Based on Table 1, the questionnaire results show that only 10% of students know the IIC learning media. At the practicum indicator point, 15% of students did practicum before. Based on the needs analysis, all students stated that the teacher had used a variety of learning media in the form of whiteboards, PowerPoint and learning videos. That only 10% of students used IIC in learning. According to Sukarjita (2020), one form of IIC Science is a set of practical tools used by students. Therefore, IIC Science as a learning medium Susilo (2020), has the potential to support practicum in schools. The use of IIC in learning was expected to make it easier for students to understand the concepts of subject matter. For teachers, IIC functions like other media, namely making communication with students easier.

One of the functions of school facilities and infrastructure is to facilitate the learning process including laboratory rooms, projectors, smartphones and internet networks. In this research, a science IIC was developed that was done in the laboratory. Learning in the laboratory room aims to allow students to freely use the IIC and students to work together in using tools and materials to carry out experiments. Meanwhile, resources in the form of projectors, smartphones and internet networks were used as additional learning tools. The projector was used as a powerpoint and video viewer. Smartphone resources and internet networks function to assist students in completing the activities available on student worksheets.

Design stage

The design of learning tools (teaching modules, student worksheet, test questions) was to serve as a reference for implementing IIC in science learning (Sukarjita, 2020; Izzania & Widhihastuti, 2020; Subamia *et al*., 2015). The science IIC developed in this research was named AquapartBox. The reason for naming "AquapartBox" came from the three words aqua, particle and box. Aqua means IIC which was created to integrate the problem of polluted water in the environment. This IIC design is intended to introduce students to environmental issues (Tapilouw *et al*., 2017; Nabila *et al.*, 2023). AquapartBox presents learning material by connecting it with water purification as a solution to aquatic environmental problems (Naftalina *et al*., 2021; Akbar *et al*., 2021; Arum *et al*. 2024). The word particle means IIC which was developed for substance materials and particle models. The word Box means a IIC that is packaged in a box-shaped container. The planned box functions to protect the IIC components during storage and preparation for use. Aquapart IIC is a form of learning innovation that is different from previous learning (Nugroho, 2019; Pertiwi, 2024) to improve the quality of learning (Permana, 2022; Bereki, 2022).

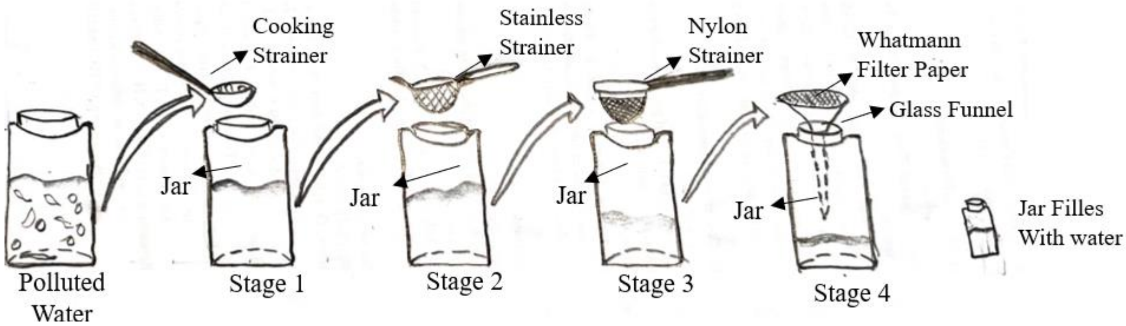

Figure 2. Design of IIC Components

Figure 2 shows the components that make up the AquapartBox IIC which consists of a jar, food filter, stainless filter, nylon filter, filter cloth and glass funnel. These components have different functions (1) The jar functions as a temporary water reservoir at each stage of separation; (2) Filters of various types function to separate water from previously mixed solid pollutants; (3) The glass funnel functions as a tool to transfer liquids at the final separation stage. These components are stored in a storage area which consists of partitions to make it practical. In the AquapartBox IIC storage area, the jar holder with the various filters and funnels are placed separately. The jars were placed between partitions to protect and avoid shocks. Meanwhile, the filter and glass funnel are placed in the same space to make it more compact. The design of the IIC also takes into account the opinion of Triswidiyanto *et al.* (2024), who states that the components and materials are easy to obtain economically.

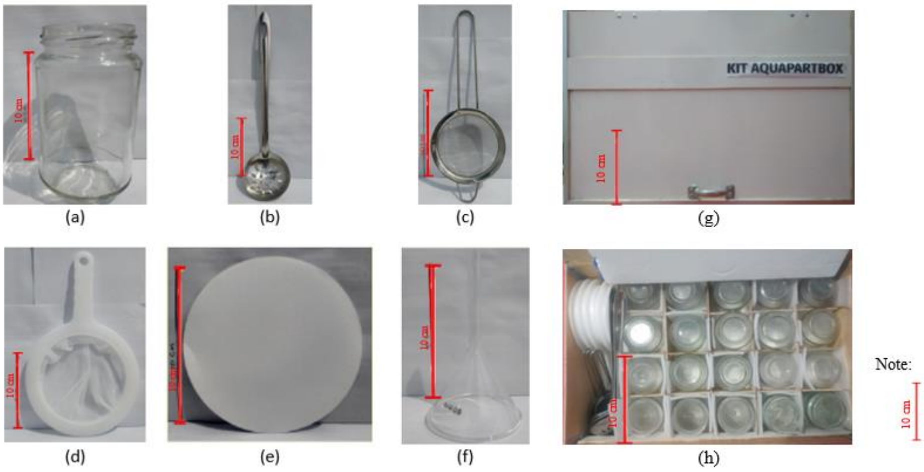

Figure 3. IIC Components (a) Jar; (b) Cooking Strainer; (c) Stainless Strainer; (d) Nylon Strainer; (e) Filter Paper; (f) Glass Funnel; (g) Closed Storage Box; (h) Open Storage Box

Based on Figure 3, the IIC component consists of a glass jar so that contaminated liquid/water can be easily observed by students and is easy to clean. The cooking strainer (Figure 3(b)) as the first filter was chosen because the size of the filter's hole is ± 5 mm. The second filter is a stainless strainer (Figure 3(c)) with the size of the filter's hole is± 1 mm. The nylon strainer (Figure 3(d)) in the third stage has the size of the filter's hole is 0.149 mm. The final stage is filtering Whatmann filter paper no. 42 (Figure 3(e)) with the size of the filter's hole is 0.024 mm. The use of various sieves with different hole sizes aims to separate particles based on size and state (liquid and solid). Organic solid pollutants are divided into Dissolved Organic Matter (DOM) measuring ≤ 0.1 µm and Particulate Organic Matter (POM) measuring > 0.1 µm, DOM is in the form of colloids and materials that dissolve in water while POM is in the form of plankton, algae and insoluble organic materials water (Monroy *et al*., 2017). Inorganic plastic pollutants can be macroplastics (size >5 mm), mesoplastics (size 1-5 mm), and microplastics (size >1 mm) (Ziani *et al*., 2023). The main material chosen for the AquapartBox IIC storage box is plywood which has strong and light characteristics (figure 3 b,c). The corners of the storage box are coated with aluminum to make the box tidier. The strength of this AquapartBox IIC is very important to avoid changes in form when IIC is used in learning (Pribowo, 2018).

Development stage

AquapartBox IIC validation consists of two aspects:the media and the material aspect. Media aspect validation measured by the suitability of the IIC as a learning media in science learning implementation. Validation of material aspects measured by the compatibility of the IIC according to science learning material. Validation of the AquapartBox IIC was carried out by media experts and material experts, including teachers and lecturers.

Table 2. *AquapartBox* IIC Validation

Indicator	**Score**	
	Material Aspect	**Media Aspect**
Visual	4.56	4.5
Safety	4.56	4.75
Practical use	4.67	4.75
Averages	**4.59 (92%)**	**4.67 (93%)**
Criteria	**Very Valid**	**Very Valid**

Validation indicators were based on Zulirfan *et al.* (2021), including the use of visual, safety, and practical use. Based on Table 2, the average media aspect validation was 93%. In the media aspect of security and practical use indicators, a score of 4.75 was obtained. These results show that the AquapartBox IIC was safe for students to use and easy to use. The display indicator received a score of 4.5, which showed the IIC's good appearance. So, the AquapartBox IIC motivated students to learn. Overall, the AquapartBox IIC was in "very valid" criteria in the media aspect (Riduwan, 2012).

Table 2 shows the results of validation of material aspects with a percentage of 92%. The indicator with the highest score in the presentation indicator (4.67), showed that the AquapartBox IIC was presented coherently and supported active students. The curriculum and material suitability indicators have the same validation value, (4.56), which showed that the AquapartBox IIC was compatible for use in substance and particle model materials. So overall the AquapartBox IIC is classified as very valid in terms of material aspects (Riduwan, 2012). According to Gogahu & Prasetyo (2020), media aspect validation aims to assess the advantages and disadvantages of the media in terms of the material presented.

At this stage, the validator suggested selecting pollutants before the AquapartBox IIC is used. Therefore, pollutants were selected, leaf pieces, plastic pieces, paper pieces, twig pieces, gravel and sand according to the real situation of water pollutants in water bodies. At each stage of separation, objects remaining on the filter were found.

Figure 4. Laboratory work for IIC (a) trial; (b) implementation

Small-scale trials were carried out on ten randomly selected students. In Figure 4, students filled out a trial questionnaire based on learning media and tools. The results of the trial are listed in a table where the criteria have been determined. This trial aims to perfect the learning media being developed (Putri *et al.*, 2021). The tests on the AquapartBox IIC trial obtained an average of 74%. In this trial, the material indicator obtained the highest score (3.9), which indicated that students are interested in using IIC in this material. The display and security indicators got the same value (3.6). The display indicators described students' interest in the AquapartBox IIC display. The safety indicator shows that the IIC is not dangerous and can be used repeatedly. In the trial, criteria of the AquapartBox IIC was "decent". AquapartBox IIC was developed in three stages of analysis, design, and development. The analysis shows that IIC has the potential to be developed in studying substance and particle models. The design stage produces sketches and AquapartBox IIC products. The IIC development stage in validation in material aspect (92%) and media (93%) was very valid

3.2. Effectiveness of AquapartBox IIC

Implementation Stage

The implementation was divided into two meetings, the time allocation for each meeting was 2x40 minutes. The method used in learning was PBL (Problem Based Learning). At the first meeting, students learned by doing activities in the student worksheet in groups. At the second meeting, students used the AquapartBox IIC to solve a problem through practicum in accordance with the opinions of (Arini & Darmayanti 2022; Marcella *et al*., 2018). Apart from that, students learn that water pollutant particles consist of various sizes (Bahtiar *et al*., 2022; Kumala *et al*., 2019), from 0.024 mm to 5 mm.

Table 3 shows the average increase in implementation of the PBL teaching module from meeting 1 to meeting 2. The average implementation by teachers increased from 89.63% to 90%. Average implementation by students increased from 86.06% to 88%. Syntax (1) students' orientation towards the problem showed a decline, teachers and students at meeting 1, which was originally 100%, became 50% at meeting 2 This decrease occurred because the video of environmental problems was unable to display in front of the class. The students watch the videos independently by smartphone. Syntax (2) organized students to learn which was carried out entirely by the teacher and students at all meetings.

Table 3. Implementation of PBL lesson plan

Learning Syntax	**Implementation %**			
	Meeting 1		**Meeting 2**	
	Teacher	**Student**	**Teacher**	**Student**
Student orientation to problems (1)	100	100	50	50
Organizing students to learn (2)	100	100	100	100
Guiding individual and group investigations (3)	100	75	100	90
Develop and present results (4)	83.35	83.35	100	100
Analyze and evaluate the problem solving process (5)	66.7	66.7	100	100
Average	**89.63**	**86.06**	**90**	**88**

Syntax (3) guided individual and group investigations showing that the implementation of PBL among teachers was carried out entirely in meetings 1 and 2. The syntax among students has increased from 75% to 90%. Syntax description 3 (Figure 6) is that students used the Aquapart IIC in learning with student sheet guidance. In the second meeting of this syntax, water purification practicum was carried out. The implementation of this syntax was strengthened by the opinion of Arum *et al*. (2024), who stated that water purification is a learning innovation. Syntax (4) showed an improvement in the implementation of teaching modules from 8.35% to 100% at meetings 1 and 2. This increase was experienced by teachers and students. Syntax (5) analyzes and evaluates the problem solving process showing an increase in implementation from meeting 1 (66.7%) to meeting 2 (100%). Pretest and posttest were used to measure students' knowledge. The pretest was carried out at the beginning of the lesson at the first meeting, while the posttest was carried out at the end of the lesson at the second meeting. The pretest and posttest were analyzed to produce N-Gain. N-Gain is a score for increasing students' knowledge before and after being given treatment (Feliyawati & Widodo, 2022; Jannah & Shofiyah, 2024). In this research, the results of N-Gain are shown in Figure 5.

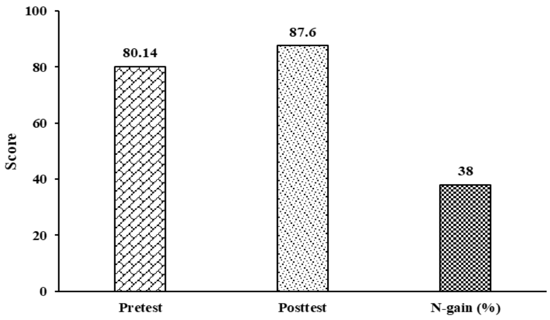

Figure 5. Student n-gain graph

Based on Figure 5, the N-Gain obtained is 38%. The N-Gain was obtained from the difference between the students' pretest and posttest, which was originally 80.14 to 87.6. Based on the criteria of Ramdhani *et al*. (2020), the N-gain obtained shows that students' knowledge has increased in the medium category. The medium category N-gain results show that AquapartBox IIC improves learning outcomes. The medium results are influenced by the previously high pretest scores and AquapartBox IIC improves learning outcomes.

Evaluation Stage

The questionnaire given to teachers and students has five indicators (Table 4). The questionnaire produces teacher responses and student responses. Based on Table 4, the highest response given by students was in the motivating indicator (4.08). These results are in accordance with Sukarjita's (2020) & Sanulita *et al*. (2024) statement, which states that learning media increases the focus and motivation of students. This value shows that students were engaged in learning by using the AquapartBox IIC. Student responses on average (3.89) are grouped in the effective category.

Table 4. Final evaluation of students

Indicator	Score	
	Student	**Teacher**
Practical use	4.13	4.75
Material	3.83	4.25
Motivating	4.08	4.5
Visual	3.58	3.75
Presentation	3.83	3.5
Average	**3.89 (77.8%)**	**4.15 (83%)**
Criteria	**Effective**	**Very Effective**

Based on Table 4, the highest teacher response was on the ease of use indicator with a value of 4.75. This value shows that instructions of using the AquapartBox IIC were well prepared. According to Pribowo (2018), instructions for using learning media make it easier for students to operate IIC. Teacher's responses with high scores are also obtained in the motivation indicator (4.5). The teacher's response was related to the implementation of the AquapartBox IIC in motivating students to participate in learning. The next high response was obtained by the material indicator (4.25). This response shows that the implementation of AquapartBox IIC was able to increase student's understanding about substance and particle model material. Learning media increases understanding through ease of delivery of material between teachers and students (Subamia *et al*. 2015). Other indicators received a value of 3.75 for appearance and 3.5 for presentation respectively. Teacher responses on average (4.15) are grouped in the very effective category. The effectiveness of the AquapartBox IIC was obtained through the implementation and evaluation stages. At the implementation stage, AquapartBox IIC was used in science learning as demonstrated by the implementation of the PBL lesson plan. At the implementation stage, N-gain was obtained which shows the results of increasing student knowledge in the medium category. In the evaluation stage, student responses were obtained which showed learning was in the effective category and teacher responses showed learning was in the very effective category.

4. CONCLUSION

The AquapartBox IIC validation results for material and media aspects are in the very valid category. AquapartBox IIC is very valid on visual, security, and practical use indicators. Using AquapartBox IIC increases students' knowledge in the medium category based on the N-Gain score. The implementation of PBL Lesson Study has by student and theacher has increased. Evaluation by students shows that IIC learning media is effective and the teacher shows it is very effective. The results of the development of AquapartBox IIC media show an increase in student learning outcomes and learning effectiveness. Based on the research results, AquapartBox IIC is a solution for schools that experience limited practical equipment. For teachers, the research results add insight to develop learning media.

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