Development of Science Learning Modules Based on Project Based Leraning on Additives and Addictive Substances (A Research in Class VIII SMP Negeri 7 Telaga Biru)

Alpinawati N. Masaguni[1], Chairunnisah J. Lamangantjo[1*], Nancy Katili[1], Masrid Pikoli[1], Trisnawaty Junus Buhungo[1], Citron S. Payu[1]

[1] Department of Science, Faculty of Mathematics and Natural Sciences, Gorontalo State University, Gorontalo, Indonesia.

Abstract: This research is a development research (*Research and Development*) which aims to determine the validity, practicality and effectiveness of developing a Project Based Learning (PjBL) science learning module on additives and addictive substances. This research uses the ADDIE model up to the stage (Analysis, Design, Development, Implementation and Evaluation) and was tested in class VIII SMP Negeri 7 Telaga Biru with a one group pre test-post test design. The results showed that: (1) The developed module obtained an average of 3.66 with a valid category obtained through the validity test; (2) The developed module is practical as indicated by the learning is very well implemented with an average percentage of 92% and students state that the learning process using the Project Based Learning-based Science learning module is practical to be applied in the classroom; (3) The developed module is effective as indicated by students who are active in learning for three meetings with an average percentage of 85% (good category), the increase in student learning outcomes for the cognitive domain reaches an N-gain value of 0.71 including in the high category. Based on the results of this study, it can be concluded that the learning module developed is of high quality.

Keywords: Additives and addictive substances; Module learning; Project based learning

Introduction

Natural Science is one of the subjects that can be integrated with life skills education. According to Ardhani et al. (2021), Natural Science is a science related to how to find out about nature systematically and also science is not only mastery of a collection of knowledge in the form of facts, concepts but also a process of discovery. Blended science learning allows learners to gain direct experience, strengthening their ability to receive, retain, and apply the concepts they have learned. Therefore, learners are trained as a whole to discover for themselves concepts that are clearly meaningful, effective, and actively learned.

Educational assessment is part of the teacher's activities to support the achievement of these educational goals, and includes the assessment of learning outcomes in the assessment carried out by the teacher, which is carried out to measure the learning outcomes of students (Adiyono, 2022). Knowledge and skills after receiving material and instructions from the teacher. Learning Outcomes Assessment This is very important because the teacher must carry it out truly professionally and objectively because the teacher will determine whether the students are successful or not (Adiyono et al., 2023; Sawaluddin et al., 2020). In addition, Mustopa et al. (2021) also added that to obtain information about the achievement of the results of the student learning process in accordance with the predetermined objectives, an assessment of learning outcomes is needed.

Science learning in the 2013 curriculum is structured by paying attention to science process skills which include basic science process skills and integrated science process skills. This is in accordance with Sayekti (2019) that the process of understanding science is called

science process skills, namely skills performed by scientists. Science process skills are divided into two, namely basic process skills and integrated process skills. Basic process skills include measuring, observing, inferring, predicting, classifying, and communicating. Advanced science process skills include controlling variables, interpreting data, formulating hypotheses, defining operational variables, designing experiments, and conducting experiments.

Many factors affect the success of students in carrying out science learning both from students and educators themselves. One of the factors from students is the low student learning outcomes in science lessons, while the factors caused by educators include the ability of the educators themselves to master/organize the material to be taught to students and the availability of learning facilities. In addition, according to Rubiana (2020) that the characteristics that students must have to achieve learning success. One of these characteristics is learning motivation.

This is obtained from the results of observations in the form of interviews with one of the science teachers at SMP Negeri 7 TelagaBiru, that the learning methods used so far still use conventional methods, namely the lecture and question and answer method. Learning using these methods has not encouraged students to learn independently. As a result, students tend to be passive and bored in the learning process. Students only record and listen to the explanation given by the teacher, and are lazy to seek knowledge outside the teacher's explanation. According to Sobron et al. (2019), the lecture method is a method or step used by the teacher in the process of teaching and learning activities with direct oral explanations to students. The learning process using this method is only suitable for conveying information, introductions and material related to understanding or concepts. Meanwhile, the question and answer method is a way of presenting lessons in the form of questions that must be answered, especially from teachers to students, but can also be from students to teachers (Anisah, 2022).

The use of conventional methods, the use of modules in the learning process is also a factor in determining the quality of learning. This is in accordance with Mardianti et al. (2020), one way that can be done to improve the quality of the learning process is to use modules or teaching materials. In the learning process that occurs in class VIII SMP Negeri 7 Telaga Biru, students only use textbooks provided by the government which tend to be boring because there are no other supporting books, so students become lazy to study them. Given that the textbooks provided are very minimal and also the available textbooks have not been able to guide/provide guidance to students to be able to

learn students independently, so that students are less motivated to learn which has an impact on the low learning outcomes of students. This is in accordance with Rismawati et al. (2020), the learning motivation possessed by a student can directly affect his learning outcomes. If students have good learning motivation, the resulting learning outcomes will also be good. Vice versa, if students in learning do not have good motivation, it will definitely have an impact on poor learning outcomes as well.

The textbook intended in the process used is a module, a module is a printed teaching material designed to be studied independently by students. Modules are also called media for self-study because they are equipped with instructions for self-study. This means that readers can carry out learning activities without the direct presence of the teacher. According to Yuristia et al. (2022), the module is a form of teaching material that is interesting and easy to understand because the module is designed using images that attract students to learn it, not only that the material applied in the module is also material that is easy to understand.

A good module is a module that is prepared by the teacher himself by taking into account the characteristics of the students. The characteristics of the students themselves are only known by the teacher. Student characteristics at school include student needs, participation in learning, student interests and initial abilities that have been mastered. This is in accordance with Tamami (2020), modules developed by teachers themselves can be adjusted to the characteristics of students which include social, cultural, and geographical environments, stages of student development, initial abilities that have been mastered, interests, and family backgrounds.

Modules that are prepared by the teacher himself will be easier and more effective if used in the learning process. Because the teacher masters the contents of the module that has been made so that the teacher is easier to convey or explain the learning material. However, there are still many teachers who feel unable or do not have time to make their modules so the package books provided by the government are the only books used in the learning process. According to Rahimah (2022), teachers in education units are obliged to compile teaching modules completely and systematically so that learning takes place interactively, inspiring, fun, and challenging, motivating students to participate actively, and providing sufficient space for initiative, creativity, and independence by the talents, interests and physical and psychological development of students.

The factors that cause low science learning outcomes as described above are a challenge for every science teacher, to foster student interest and motivation

so that learning outcomes can improve. To further improve science learning outcomes, teacher creativity or innovation in learning is needed. Especially in science learning, in this case, the material of Additives and Addictive Substances. This is in accordance with Jannah et al. (2022), teacher creativity is needed in managing appropriate and efficient learning media in achieving science learning goals.

One of the things that can increase learning motivation is providing interesting learning resources that are systematically arranged and can be used by students both at school and outside the school environment. Rahmawati (2020) argues that in increasing learning motivation, educators should use varied learning resources so that students do not feel bored in the learning process and that learning objectives can be achieved.

In response to this, currently, there are many utilization of learning modules that are interesting and can help students to improve student understanding of the learning process both at school and at home. One form or type of media used by teachers to increase students' interest and motivation in the material being taught is learning modules. This is in accordance with Al-Azka (2019), the ways that teachers can create and develop teaching materials include using approaches in the process of developing teaching materials, which are by the material to be delivered. One type of teaching material that can be developed by teachers is learning modules.

The module is defined as a complete unit, stand-alone, and consists of a series of learning activities to achieve several objectives that have been formulated specifically and clearly. Formulated by the Education Development Agency of the Ministry of Education and Culture (Kosasih, 2021). In addition, according to Manaf (2022), a module is a unit of learning program that is arranged in a certain form for learning purposes, in this sense it can be seen that the module in question is an instructional module.

Additives are chemical compounds that are specifically added to prevent the decomposition of food substances caused by microbes and inhibit microbial growth and activity, namely by damaging the cell membrane or cell wall of the microbes and reducing enzyme activity (Rorong et al., 2019). Meanwhile, addictive substances are active substances that when consumed by living organisms, can cause biological work and cause dependence or addiction that is difficult to stop and has the effect of wanting to use it continuously (Siregar et al., 2022).

The characteristics of additives and addictive substances in learning require concrete media to understand the concept, so an appropriate learning model is needed. One of the learning models that provides an active role for students to construct and search for their knowledge is the *project-based learning* model. According to Wahyuni (2019), *project-based learning* is a learning model that provides opportunities for educators to manage learning in the classroom by involving project work. In addition, Handayani (2020) also added that the project-based learning model will create a challenge and collaboration, students will be forced to work together, which will train empathy and the ability to encourage cooperation between them.

Based on the explanation above, the researcher felt the need to develop a learning module based on project-based learning, considering that the development of this module is still rarely done. In addition, the reason for the researchers to integrate the project-based learning model in this module apart from being seen from the characteristics of the material is that the integration of the project-based learning model in the development of learning modules is still very rarely done by subject teachers.

In addition, in the project-based learning model, students not only listen and pay attention but are also directly involved in learning. This model can improve students' abilities by involving them in making or creating an idea in the form of a work/product, thus helping students understand the material (Mawardi et al., 2020; Nahdiah et al., 2021).

Based on the description above, researchers have conducted research with the formulation of the title Development of Project-Based Science Learning Modules on Additive and addictive substances in Class VIII SMP Negeri VII Telaga Biru.

Method

This research is a type of development research (Research and Development) leading to the development of project-based learning modules that can produce a valid, practical, and effective Learning Module. The research and development (R&D) method also called the development method is defined as a method used to deepen and expand existing knowledge (Hasanah et al., 2015; Sugiyono, 2015).

This research refers to the ADDIE development model developed by two experts, namely Reiser and Molenda. According to Setiawan et al. (2021), the ADDIE development model is a development model consisting of five stages, namely, Analysis, Design, Development, Implementation, and Evaluation.

The ADDIE model was chosen in this research because it is a product-oriented learning design model. The ADDIE model can be used to develop various products, such as learning media, teaching materials,

learning methods, learning strategies, and learning models. The steps in this research refer to the development of ADDIE as follows.

The analysis stage is the first stage in the ADDIE model learning module development process to design and develop a learning module. In the analysis there are two stages, namely needs analysis and curriculum analysis. At the needs analysis stage, the researcher conducts an analysis process by collecting supporting data and information that becomes a problem of science learning. The results of this process describe the problems that are being faced by students so that solutions need to be sought and alternative solutions that will be used to overcome the problems that have been identified. So researchers need to do the curriculum analysis stage. At this stage, the researcher formulates the objectives that will be achieved during learning on the science learning module. The design stage is the second stage of the ADDIE development model to design and develop learning modules in the form of projects contained in the learning module and assessment sheets by creating and modifying them according to the project-based learning model. Before making the product, the researcher determines the material based on the results of the interviews obtained, namely the material that is felt to be difficult for students to understand. The development stage is the stage of realization of the design into a product (draft I). The learning module that has been designed is then developed. At this stage, the development of learning modules designed in the previous stage will produce products (draft I). The learning module will be developed in the form of projects contained in the learning module and assessment sheet by the project-based learning model which will have the aim of improving learning outcomes in students. The learning module that has been developed is then validated by experts who aim to find out the validation of the learning module developed suggestions and improvements. The learning module that has been developed in the previous stage is then applied to students through the learning process carried out in the classroom. The implementation of this learning is carried out in one class, namely in class VIII SMP Negeri 7 Telaga Biru which is determined by probability sampling technique (simple random sampling), namely the type of probability sampling of each person throughout the target population who has the same opportunity to be selected, but the selection of this sample is done randomly and not sequentially. Learning is carried out for 3 meetings and ends with a response questionnaire that will be filled in by students to assess learning activities using the project-based learning model. The evaluation stage is used to determine the quality of the

learning module developed by the researcher which includes validity, practicality, and effectiveness. A quality learning module is a learning module that is valid based on validation analysis, practical based on learning implementation and student responses, and effective based on student activity and student learning outcomes.
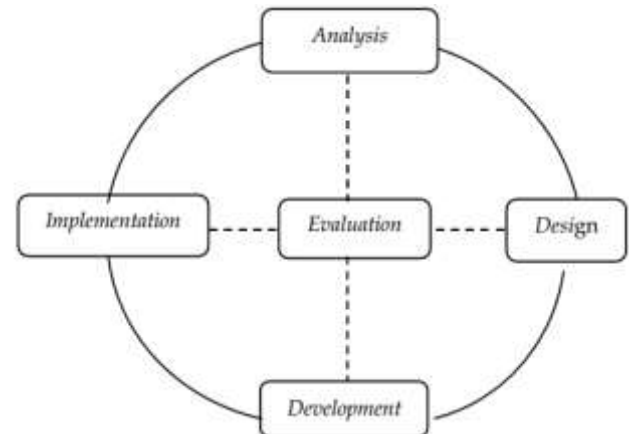

Figure 1. Schematic of ADDIE research steps

According to Sugiyono (2015) data collection techniques are the most important step in research because the main purpose of research is to obtain valid data. Without knowing the data collection technique, the researcher will not get data that meets the established data standards. The data used are:

Validation is used to determine the validity level of the learning module developed. Data on the validity of the learning module developed was obtained through a validation sheet instrument given to the validator for comment. The data collection technique in this research is useful for knowing whether the learning module developed is valid or not. The learning modules used were validated by 3 expert validators with the validated modules being learning modules and student learning outcomes tests.

The module practicality test in the data collection technique uses the learning implementation observation sheet to see whether the learning process is implemented or not. Observation of the implementation of learning based on the steps or syntax in the lesson plan, carried out by 2 observers and carried out for 3 meetings of additive and addictive substances. Each aspect observed will be assessed using a check mark ($\sqrt{}$) in the column provided. The stages of the learning process that are observed include introductory activities, core activities, and closing activities, which aim to see whether the learning process is carried out or not.

The learning module effectiveness data observation sheet is used to see the activities of students and to what extent students are interested in learning using the

learning module that has been developed during the learning process. The observation sheet used is an observation sheet in the form of a checklist (√). The researcher only needs to provide a checklist in the column provided. Observation is carried out during the learning process.

The data analysis technique in this research uses descriptive analysis. Descriptive analysis aims to determine the quality of the product in the form of a science learning module based on project-based learning.Instruments in the form of tests and content validation testing can be used by comparing the content of the instrument with the subject matter that has been taught (Sugiyono, 2015). The modules to be validated include learning modules that contain learning projects and learning outcomes tests on students. In this research, the average score (P) of expert and practical assessments is adjusted to the learning module criteria as shown in Table 1.

Table 1. Module Feasibility Criteria (Purnomo, 2014)

Score Interval	Assessment Criteria	Description
3.5 ≤ P < 4	Very Valid	Can be used without revision
2.6 ≤ P < 3.5	Valid	Can be used with minor revisions
1.6 ≤ P < 2.5	Less valid	Can be used with many revisions
1 ≤ P < 1.5	Not Valid	Not yet usable and still requires consultation

The learning module is said to be practically used by using the learning implementation observation sheet of the learning module for each aspect by using the option of choice, namely implemented and not implemented. To find out the percentage of implementation of activities in all aspects of learning, the formula is used:

$$\% \text{ Implementation of learning} = \frac{many\ steps\ accomplished}{number\ of\ planned\ steps} X\ 100\% \quad (1)$$

The assessment of learning implementation was carried out by matching the results of the average score given with the learning implementation as shown in Table 2.

Table 2. Criteria for Learning Implementation (Purnomo, 2014)

Value	Criteria
81%-100%	Very good/veryinteresting/very appropriate/ very effective/very practical
61% - 80%	Good/interesting/effective/practical
41% - 60%	Moderate/quite attractive/quiteappropriate/ quite effective/quite practical
21% - 40%	Less good/less attractive/less suitable/less effective/less practical

Questionnaires or questionnaires are to collect data in the form of a list of questions submitted to respondents to be answered in writing (Hamdi, 2014). Questionnaires are used to find out the responses of students regarding the development of this learning module and to determine the feasibility of the product as a basis for revising the product. The research instrument uses a Likert scale, namely by giving a score of 1 (strongly disagree), 2 (disagree), 3 (agree), and 4 (strongly agree).

The effectiveness of a learning module that has been developed can be obtained through analysis of learner activity and learning outcomes. In following the learning process for three meetings, the results of the observation of students' activities were analyzed using the formula:

$$\% \text{ Learner activity (pa)} = \frac{number\ of\ scores\ obtained\ (A)}{maximum\ score\ (N)} X\ 100\% \quad (2)$$

Assessment of learner activity is done by trying the average total score obtained with the criteria in Table 3.

Table 3. Learner Activity Criteria

Value Range	Interpretation
86 % - 100 %	Very Good
76 % - 85 %	Good
66 % - 75 %	Simply
56 % - 65 %	Less
0 % - 55 %	Very Less

Students' activities are said to be effective in learning if 76% of students are in the good category. Data on student learning outcomes in the cognitive domain (knowledge) can be analyzed using the formula:

$$\text{Individual completeness} = \frac{students\ who\ completed}{maximum\ score} X\ 100\% \quad (3)$$

The results of calculations using the formula above will obtain data on the achievement of minimum completeness, which can then be used to calculate the percentage of classical student learning completeness. The formula used is as follows.

$$\text{Classical completeness} = \frac{students\ who\ completed}{number\ of\ students} X\ 100\% \quad (4)$$

Table 4. Classical Completeness Criteria

Value	Classification
(<g>) ≤ 0.3	Low
0.3 < (<g>) < 0.7	Medium
<g> ≥ 0. 7	High

The project-based learning module is declared effective if the classical completeness of students reaches 71% with good and very good criteria. Data on learning

outcomes obtained by students are interpreted according to the criteria in Table 4.

Data analysis of the presentation of improved learning outcomes using n-gain analysis. Data from the initial test results and the final test of students' learning both individually and in groups, then calculated the increase expressed in n-gain. To get the n-gain value of the learning outcome test score use the following equation:

$$g = \frac{\% \, scor \, post - \% \, scor \, pre}{100 - \% \, skor \, pre} \qquad (5)$$

Description:

g   = gain in learning outcomes
pre score   = average scorepre test (%)
post score   = average scorepost test (%)
Magnitude of factor <g> can be seen in Table 5 (Hake, 1999).

Result and Discussion

This research uses the development of the ADDIE model developed by Reiser and Mollenda which aims to develop learning modules that are tested based on their quality and feasible to implement. The quality described from the product developed if it meets three aspects, namely valid, practical, and effective. The research results for the validity, practicality, and effectiveness of learning devices can be described as follows:

The validation of the learning module is carried out by the validator by looking at the assessment aspects including content quality, concept correctness, concept depth, language feasibility, and quality of completeness/supporting materials. According to Anggreni et al. (2020), the use of expert validation or validators aims to obtain expert opinions about devices and products made based on certain aspects.

The results of the validation of the learning module by 3 validators obtained an overall average of 3.66 validators and included the valid category with a little revision. Thus, the learning module developed was declared suitable for use in research. This is in accordance with Awuy et al. (2023), a learning device that will be tested must pass the validation stage carried out by experts/material experts, this aims to determine the validity of the device developed before it is finally applied/tested.

The preparation of learning outcome test sheets refers to cognitive competencies that are given before and after learning takes place. According to Awe et al. (2019), one of the learning resources and learning media that is considered to help the learning process is student worksheets. Validation of the learning outcomes test (THB) conducted by the validator by looking at the research aspects including construction, content, readability, and language. The learning outcomes test used in this research is an essay test consisting of 15 questions. THB which is validated by experts is equipped with THB grids that show the cognitive level and there is also a marking scheme, namely scoring guidelines which are also validated by experts. Based on the THB validation in Table 1, the results of the validation of the validated learning test sheet can be categorized as valid because the average value obtained from all validators reaches 3.71 and it can be seen that 3 validators stated that the learning outcome test was declared valid with minor revisions so that the learning outcome test sheet could be used.

The implementation of learning in 3 meetings observed by observers during the learning process can be seen based on the sequence of Learning Implementation Plan activities that are carried out on the topic of additive and addictive substances. The percentage of data on the implementation of learning in 3 meetings is also shown in Figure 2.
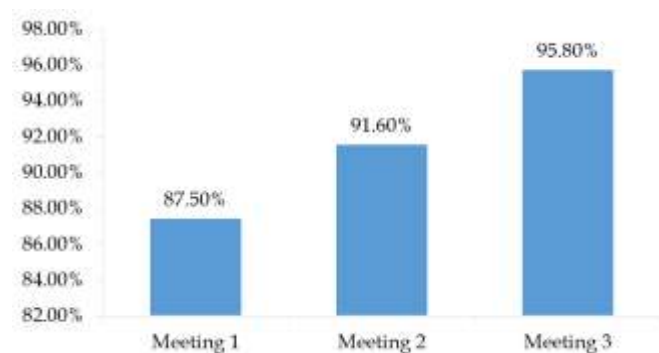

Figure 2. Percentage of learning implementation

Based on Figure 2 shows the percentage of learning implementation which in its implementation for 3 meetings reached very good criteria. In Figure 2. It can be seen that the implementation of learning, both meetings 1 2, to 3 have an overall average value of 92% and obtain very good criteria based on the criteria according to Purnomo (2014). According to Masliani (2018), learning implementation is one of the indicators of success in research on the development of a learning device.

The questionnaire of students' responses to learning using the Project Learning-based Science learning module was given after the learning process for 3 meetings was completed. According to Raisa et al. (2018), the student response questionnaire can be used as a reference for improvements to the learning model in the hope that the learning model can be used optimally. Scoring for each statement uses a Likert scale. The learner response questionnaire consists of 5 indicators which are presented in 25 statement items consisting of

positive and negative statements. The indicators include students' opinions about project-based learning, students' impressions of project-based learning, students' feelings during project-based learning, students' interest in using learning modules in project-based learning, students' learning outcomes after participating in learning, and the effectiveness of using learning modules.
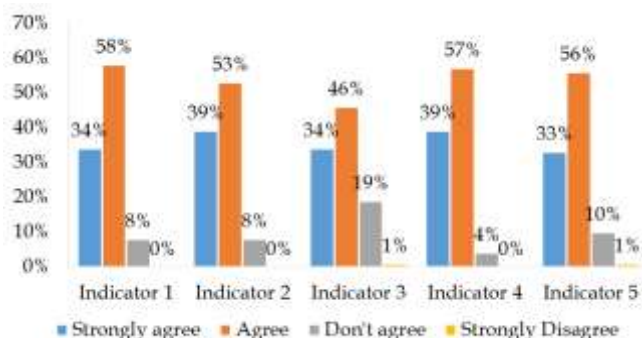

Figure 3. Percentage of students' response to project-based learning

In Figure 3, the results of the learner response questionnaire show that the majority of students (81%) gave a positive response about learning using the project-based learning module developed. Therefore, this shows that based on the student's responses, the learning carried out has met the requirements of practicality so that it can be implemented in teaching and learning activities.

The quality of a product is also seen in its effectiveness. The effectiveness of the learning module is seen from the activities of students during learning activities, as well as an increase in learning outcomes on additive and addictive substances. According to Yulaika et al. (2020), the effectiveness of learning modules can have a positive impact on improving student learning outcomes and increasing student activity. A description of the results of student activity and learning outcomes test data is as follows:

Assessment of learner activity is carried out by observers during learning takes place for 3 meetings by filling in the learner observation sheet and looking at the learner's number to facilitate the observer in providing an assessment. In the activity of students, there are 11 assessment indicators. The percentage of student activity data during the learning process in 3 meetings is also shown in Figure 4.

Figure 4 shows the percentage of student activity data during learning which consists of 3 meetings. Cognitive learning outcomes using assessment sheets in the form of learning outcomes tests in the form of essays. According to Pebriani (2017), cognitive learning outcomes are the results of activities that have been done

by students through student skills related to thinking skills; the ability to acquire knowledge; and abilities related to the acquisition of knowledge recognition, understanding, conceptualization, determination, and reasoning.
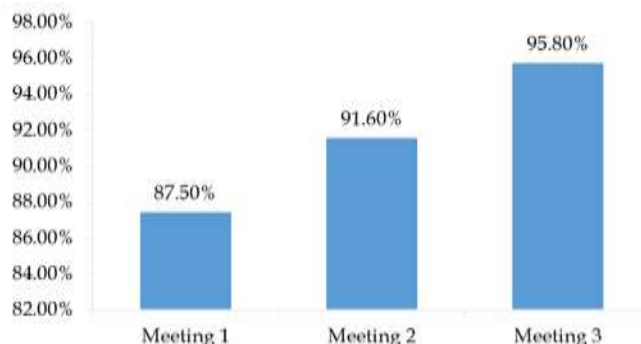

Figure 4. Percentage of student activity

The test is given before learning (pre-test) and after learning (post-test). According to Sudijono (1996) and Effendy et al. (2016), the pre-test or initial test is a test carried out to know the extent to which the material or subject matter to be taught has been mastered by students. Meanwhile, the post-test is a test that is carried out to know whether all the material that is classified as important has been mastered as well as possible by students.

The test was prepared based on the question indicators that were adjusted to the learning indicators in as many as 15 questions. The improvement is measured based on the N-gain analysis. According to Sintiawati et al. (2021), the n-gain test is used to determine the increase in student learning outcomes from pre-test to post-test. Based on the tests that have been given, the overall average value of the N-gain Pre-test, and post-test is obtained in Table 5.

Table 5. Mean Values of Pre-Test, Post-Test, Difference and N-Gain

Respondents	Pre-test	Post test	Difference %	N-gain	Criteria
25	28.7	79.6	50.9	0.71	High

Based on Table 5 shows that the pre-test value is 28.7% while the post-test value is 79.6% with a difference of 50.9% with an increase in N-gain value of 0.71 ($<g> \geq$ 0.7) including high N-gain criteria based on Hake criteria (Hake, 1999).

Conclusion

Based on the results of the research and discussion, it can be concluded that the science learning module developed using the project-based learning model on

additives and addictive substances has met the quality criteria which include three aspects, namely valid, practical, and effective.

Author Contributions
Conceptualization, C.J.L, N.K, M.P, T.J.B S.Pd, C.S.P., methodology, C.J.L, N.K, M.P, T.J.B S.Pd, C.S.P.; software, A.N.M.; validation, M.P, T.J.B, and R.S.N.; formal analysis, A.N.M.; investigation, A.N.M.; resources, A.N.M.; data curation, A.N.M.; writing—original draft preparation, A.N.M.; writing—review and editing, A.N.M.; visualization, A.N.M; supervision, R.S.N.; project administration, A.N.M.; funding acquisition, Y.Y. All authors have read and agreed to the published version of the manuscript.

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