JPPIPA 9(7) (2023)

Jurnal Penelitian Pendidikan IPA

*Journal of Research in Science Education*

http://jppipa.unram.ac.id/index.php/jppipa/index

# Module Development on Basic Laws of Chemistry Based on the 5E Instructional Model to Improve Science Process Skills in Senior High School

Fitrah Mey Harmi Siregar[1], Rahadian Zainul[2*], Andromeda[2], Budhi Oktavia[2], Amalia Putri Lubis[2]

[1]Chemistry Education of Postgraduate Program, Universitas Negeri Padang, Padang, Indonesia.
[2]Department of Chemistry, Universitas Negeri Padang, Padang, Indonesia.

Received: May 19, 2023
Revised: June 18, 2023
Accepted: July 25, 2023
Published: July 31, 2023

Corresponding Author:
Rahadian Zainul
rahadianzmsiphd@fmipa.unp.ac.id

DOI: 10.29303/jppipa.v9i7.4343



**Abstract:** The module is one of the teaching materials that is arranged as a whole and systematically. Modules based on learning models can change learning patterns from teacher center to student center. One of the learning models developed specifically for subject matter in the field of science is 5E instructional. The 5E Instructional Model consists of 5 stages namely engagement, exploration, explanation, elaboration and evaluation. The purpose of this study was to develop an instructional module based on 5E chemical laws to improve the process skills of science students. The type of research conducted is research & development (R&D) with the ADDIE development model. The results obtained for the validity of the construct and content were 0.89 and 0.91 with the valid category. Based on the results of the teacher and student response questionnaires, an average practicality score of 86.96% and 86.10% was obtained in the very practical category. The results of the effectiveness test conducted in the experimental and control classes showed that the N-gain value for the experimental class was higher than the control class, namely 0.84 and 0.79. Based on the results of the t-test on student learning outcomes, it was found that tt < th means that the learning outcomes of classes using the 5E instructional module were significantly higher compared to classes that did not use the 5E instructional module. Therefore, it can be said that the 5E-based basic chemistry law module is valid, practical, and effective. The effectiveness of the developed module is seen from the learning outcomes of students and science process skills, so that this module can already be used in the learning process.

**Keywords:** Basic Laws Chemistry; Module; Science Process Skills; 5E Instructional.

## Introduction

Chemistry is the science that studies the nature and composition of matter which is defined as everything that has mass and occupies space and uses the scientific method in the form of observations made to collect empirical facts (Brady, 2012) and explain what and why a phenomenon occurs around us (Farida et al., 2011). Education is a place for humans to study chemistry.

The independent curriculum that has begun to be implemented now frees teachers and students to determine their learning system (Setiyaningsih & Wiryanto, 2022). The independent curriculum emphasizes students' understanding to apply their concepts to problems that exist in everyday life (Manalu et al., 2022).

Based on observations of teachers in several high schools in East Pasaman, it was found that the teaching materials used by the teacher were in the form of textbooks, modules and student worksheets. The teaching materials used are still not based on learning models so that the learning process is teacher-centered, not student-centered.

The learning model is a conceptual framework that describes a systematic procedure for organizing learning experiences to achieve specific learning objectives

**How to Cite:**
Siregar, F. M. H., Zainul, R., Andromeda, Oktavia, B., & Lubis, A. P. (2023). Module Development on Basic Laws of Chemistry Based on the 5E Instructional Model to Improve Science Process Skills in Senior High School. *Jurnal Penelitian Pendidikan IPA*, *9*(7), 5420–5428. https://doi.org/10.29303/jppipa.v9i7.4343

(Octavia, 2020). So, from this it is necessary to apply the learning model in the teaching materials used.

One of the learning models developed specifically for learning materials in the field of science is 5E instructional. The 5E Instructional Model consists of 5 stages namely engagement, exploration, explanation, elaboration and evaluation (Bybee, 2014). The 5E Instructional model has the advantage of helping students develop a scientific attitude so that learning is more meaningful and increases student motivation in following the learning process because students are actively involved (Cakir & Guven, 2019).

This is as explained in Ausubel's learning theory, meaningful learning is a process of associating new information with relevant concepts contained in one's cognition. Thus in order for meaningful learning to occur, new concepts or new information must be related to existing concepts in the cognitive structure of students (Trianto, 2017).

The selection of teaching materials that can be combined with learning models is also important. The module is one of the teaching materials that is arranged as a whole and systematically equipped with learning objectives, learning model syntax, material substance and evaluation that can be used inside and outside the classroom independently or in groups (Elya & Maulana, 2022). Learning model-based modules can change learning patterns from teacher center to student center so that the teacher really plays his role as a facilitator.

Education is also directed at developing students' potential and skills that can be used in living life in society, nation and state. One of the expected skills is science process skills.

Science process skills are basic skills that facilitate learning in science, enable students to be active, develop a sense of responsibility, enhance learning and research methods. Science process skills are a person's skills in using thoughts, reasoning and actions effectively and efficiently to achieve a certain result (Gürses et al., 2015).

Through science process skills, students do not only memorize concepts but witness directly proving a theory. Students' science process skills will increase along with their cognitive, affective and psychomotor abilities so that students are produced who are able to compete in the current era of intense competition. Some research results show that the application of the 5E instructional model can create an effective learning atmosphere resulting in students' science process skills increasing (Choirunnisa et al., 2018; Desouza, 2017; Lubis et al., 2022).

Based on the findings above, research on the development of basic chemical law modules based on 5E instructional was carried out to improve students' science process skills. The research objective is to develop teaching materials in the form of valid, practical and effective modules.

## Method

This type of research is development research (R&D) with the ADDIE development model. The ADDIE development model consists of 5 stages of development, namely analyze, design, development, implementation and evaluation (Sugiyono, 2013). The subjects for this research trial were three chemistry lecturers, two chemistry teachers, and students in class X at SMAN 1 Panti, Pasaman Regency, for the 2022/2023 academic year.

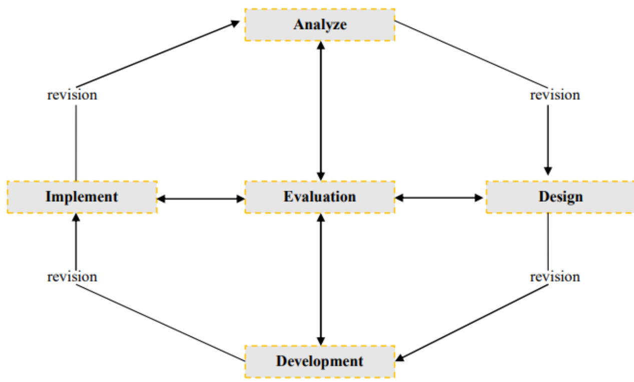



**Figure 1**. Steps of ADDIE Model

*Analyze*

At the analysis stage, an analysis of the needs needed for the development of teaching materials is carried out. The analysis carried out at this stage is curriculum analysis, needs analysis and student character analysis. The instruments used were teacher interview sheets and student questionnaire sheets.

*Design*

At the design stage several activities were carried out, namely making a checklist of the need to develop modules. Several checklists were carried out, namely collecting references related to basic chemical law material, compiling a story board module, compiling the instruments needed during the research.

*Development*

This stage aims to produce modules according to the story boat that has been designed at the design stage. The developed module will be tested for its validity level by 6 validators. The instruments used were content and construct validity sheets. The data obtained from the product validity test results were analyzed using the Aiken's V formula as in the equation below

$$V = \frac{\sum s}{n[c-1]} \quad (1)$$
$$s = r - lo \quad (2)$$

Information:
lo = The lowest score in the category (scoring) (in this case = 1)
c = Number of categories chosen by the rater (in this case = 5)
r = Score given by rater
n = Many raters

The validity criteria are based on the Aiken's V scale as follows (Retnawati, 2016).

**Table 1.** Aiken's V Scale Validity Assessment Criteria

| Aiken's V Scale | Validity |
|---|---|
| $V \leq 0.4$ | Less |
| $0.4 < V \leq 0.8$ | Medium |
| $0.8 < V$ | Valid |

*Implementation*

At this stage practicality tests and effectiveness tests are carried out on the module. Practicality tests were carried out to find out the responses and comments of students and teachers in using the product. The instrument used was the teacher and student response questionnaire sheet. The data generated from the practicality test were analyzed using the following equation.

$$P = \frac{Q}{R} x\ 100\% \quad (3)$$

Information:
P = Practicality value
Q = Score obtained
R = Highest score

The level of practicality of the developed e-module can be seen in Table 2 (Riduwan, 2008).

**Table 2.** Practicality Assessment Criteria

| Value (%) | Criteria |
|---|---|
| $80 < x \leq 100$ | Very Practical |
| $60 < x \leq 80$ | Practical |
| $40 < x \leq 60$ | Quite Practical |
| $20 < x \leq 40$ | Less Practical |
| $0 < x \leq 20$ | Impractical |

Test the effectiveness of the product seen from the comparison of the results of improving students' science process skills in the control class and the experimental class. The trial design used was a quasi-experimental (Sugiono, 2012) and the sampling technique used was purposive sampling, where the sample was determined based on certain considerations. The research design is described as follows Table 3.

**Table 3.** Research Design

| Class | Pretest | Treatment | Postest |
|---|---|---|---|
| Experiment | $O_1$ | X | $O_2$ |
| Control | $O_3$ | | $O_4$ |

The test instrument used was a question consisting of 10 multiple choice questions and 10 essay questions. Analysis of improving student learning outcomes for the modules developed was analyzed using N-Gain. Then the t-test is then carried out, but before the t-test is carried out, a prerequisite analysis test must be carried out using the normality test and homogeneity test. If the conditions are met, namely the sample comes from a population with normal distribution and homogeneity, then a t-test is performed with a significance level of 5%.

Science process skills can be seen from the ability of students to answer questions based on indicators of science process skills. The indicators of science process skills used are indicators of science process skills that are measured including observing, predicting, inferring, communicating and classifying.

*Evaluation*

The evaluation phase is carried out formatively and summatively. Formative evaluation is carried out at each stage of development while summative evaluation is carried out at the final stage in accordance with the implementation of the learning process. Summative evaluation aims to produce valid, practical and effective products so that they can be widely used in schools that need them because they have been adapted to school needs.

## Result and Discussion

*Analyze*

*Curriculum Analysis*

Based on the curriculum analysis carried out, the result is that the curriculum that applies in schools is an independent curriculum. The independent learning curriculum has learning outcomes at the end of grade 10, students have the ability to respond to global issues and play an active role in providing problem solving. The flow of learning objectives in the material on the basic laws of chemistry is to explain the basic laws of chemistry (Lavoisier's law, Proust's, Dalton's, Gay Lussac's and Avogadro's hypothesis).

*Needs Analysis*

The results of interviews with 3 high school chemistry teachers in Pasaman district found that the learning process was centered on the teacher so that students did not play an active role in learning. The teaching materials used on basic chemical laws were in the form of textbooks. The constraints experienced by the teacher in the material on the basic laws of chemistry are abstract material, there is no material available to carry out practicums and explain calculations.

The results of completing a questionnaire by students obtained that 90.86% of students stated that the teaching materials used in basic chemical law material were printed books and the dominant chemistry learning process did not carry out practicums due to constraints on tools and materials.

*Analysis of the Character of Students*

Character analysis aims to determine students' attitudes towards learning chemistry. The analysis that is devoted to this research is the level of learning abilities of students and the supporting conditions of students when carrying out the learning process. according to filling out questionnaires and interviews with teachers, it was found that students had difficulty following the chemistry learning process, especially material on the basic laws of chemistry in class X.

## *Design*

At the design stage, a basic chemical law module design is carried out based on the 5E instructional model. The results of the module design according to the syntax of the 5E instructional model are described as follows

*Engagement*

The engagement stage is the introduction stage of the basic chemical law sub-material by providing discourse related to everyday life to arouse student learning motivation and convey the learning objectives to be achieved.

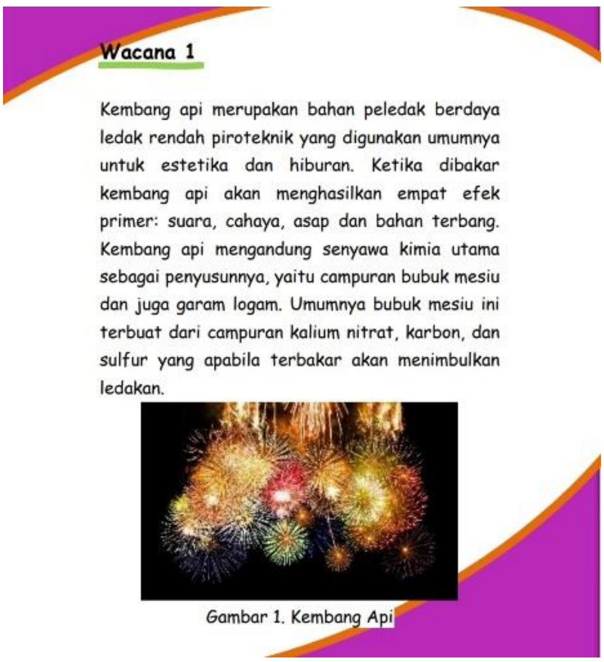



**Figure 2**. Module Display at The Engagement Stage

*Exploration*

The exploration stage is the stage where students are given the opportunity to explore information from various sources. At this stage, a summary of the material, a practicum guide and learning videos are given in the form of a barcode scan.


**Figure 3.** Module Display at the Exploration Stage

*Explanation*

The explanation stage is the stage where students explain the results of activities at the exploration stage in the form of conveying information obtained through various sources.

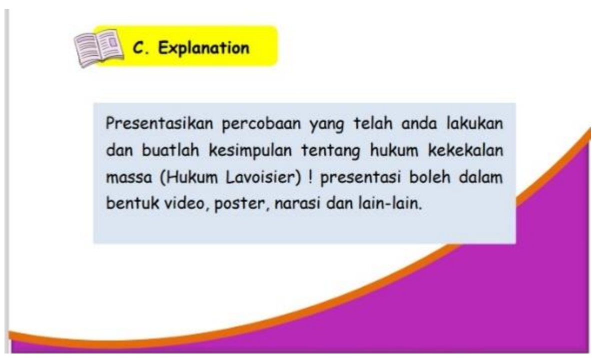
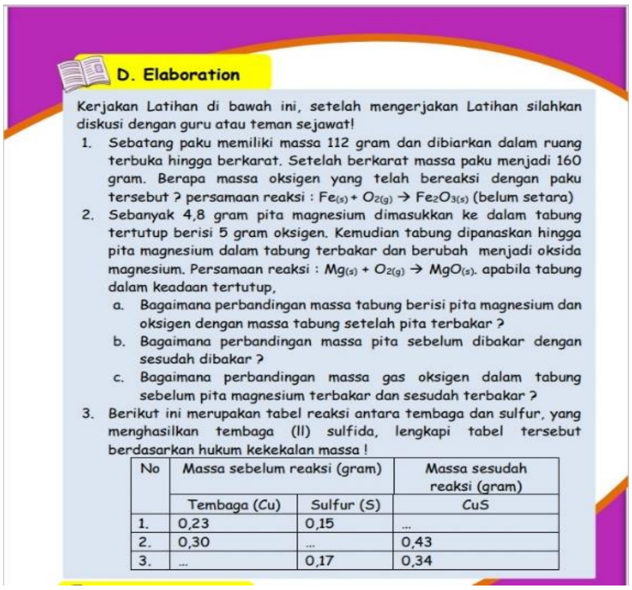



**Figure 4.** Explanation Stage Display

*Elaboration*

The elaboration stage is the stage where students collaborate with the teacher. The teacher confirms students' understanding by providing practice questions, then conducting discussions on material that students have not understood.


D. Elaboration

Kerjakan Latihan di bawah ini, setelah mengerjakan Latihan silahkan diskusi dengan guru atau teman sejawat!

1. Sebatang paku memiliki massa 112 gram dan dibiarkan dalam ruang terbuka hingga berkarat. Setelah berkarat massa paku menjadi 160 gram. Berapa massa oksigen yang telah bereaksi dengan paku tersebut ? persamaan reaksi : $Fe_{(s)} + O_{2(g)} \rightarrow Fe_2O_{3(s)}$ (belum setara)
2. Sebanyak 4,8 gram pita magnesium dimasukkan ke dalam tabung tertutup berisi 5 gram oksigen. Kemudian tabung dipanaskan hingga pita magnesium dalam tabung terbakar dan berubah menjadi oksida magnesium. Persamaan reaksi : $Mg_{(s)} + O_{2(g)} \rightarrow MgO_{(s)}$. apabila tabung dalam keadaan tertutup,
   a. Bagaimana perbandingan massa tabung berisi pita magnesium dan oksigen dengan massa tabung setelah pita terbakar ?
   b. Bagaimana perbandingan massa pita sebelum dibakar dengan sesudah dibakar ?
   c. Bagaimana perbandingan massa gas oksigen dalam tabung sebelum pita magnesium terbakar dan sesudah terbakar ?
3. Berikut ini merupakan tabel reaksi antara tembaga dan sulfur, yang menghasilkan tembaga (II) sulfida, lengkapi tabel tersebut berdasarkan hukum kekekalan massa !

| No | Massa sebelum reaksi (gram) | | Massa sesudah reaksi (gram) |
|---|---|---|---|
| | Tembaga (Cu) | Sulfur (S) | CuS |
| 1. | 0,23 | 0,15 | ... |
| 2. | 0,30 | ... | 0,43 |
| 3. | ... | 0,17 | 0,34 |

**Figure 5.** The Display of The Elaboration Stage Module

*Evaluation*

The evaluation stage is the stage to ascertain whether students have understood the learning material. This stage can be done by concluding material, making portfolios, quizzes, exams or writing assignments.

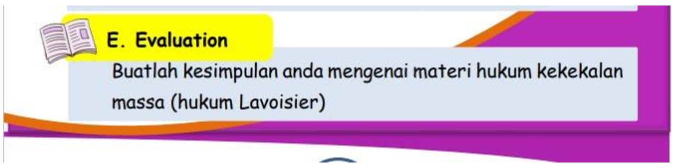



**Figure 6.** Display Module Evaluation Stage

*Development*

At this stage, the modules that have been made are tested for validity in terms of construct and content by experts. This module will be tested by six experts. Selection of the number of validators is based on opinion (Sugiono, 2012) which states that to test the validity of the instrument, expert opinion (judgment expert) can be used with a minimum number of three people.

Construct validation is related to the appearance of the developed module. Construct validation consists of 4 components, namely content components, presentation components, linguistic components and graphic components. The results of construct validation can be seen in Table 4.

**Table 4.** Construct Validation Analysis

| Rated Aspect | Aiken's V | Category |
|---|---|---|
| Content | 0.88 | Valid |
| Serving | 0.91 | Valid |
| Language | 0.89 | Valid |
| Graphic | 0.89 | Valid |
| The average value of V | 0.89 | Valid |

Based on the results of the module construct validation analysis, an average value of 0.89 was obtained with the valid category. This shows that the content of the developed module is in accordance with the learning objectives, the characteristics of the students and the basic legal concepts of chemistry. The feasibility of the contents of teaching materials shows that the contents of teaching materials have been developed based on the concepts and theories that apply in the field of science and are in accordance with the latest developments in the field of science and the results of empirical research (Hayati, 2016).

The module that has been developed also has a font size and type that is clear to read, an attractive layout design and clear images. The feasibility of module graphics can clarify the message or information conveyed and make the module more attractive because of the variation of the display (Gita et al., 2018). The macroscopic representation used has been adapted to real-life phenomena. This is in accordance with the statement (Chittleborough, Gail and Treagust, 2007) that observations at the macroscopic level can be through everyday experiences.

Content validation relates to the suitability of the module contents with the 5E instructional model syntax and the correctness of the module contents to chemical scientific content. The results of content validation can be seen in Table 5.

**Table 5.** Content Validation Analysis

| Rated Aspect | Aiken's V | | Category |
|---|---|---|---|
| | Suitability of the contents of the module with the 5E instructional model | The correctness of the contents of the module on chemical scientific content | |
| Law of conservation of mass | 0.91 | 0.90 | Valid |
| The law of fixed comparisons | 0.89 | 0.89 | Valid |
| The law of multiples | 0.92 | 0.92 | Valid |
| The law of the ratio of volumes | 0.93 | 0.93 | |
| Avogadro's hypothesis | 0.91 | 0.91 | Valid |
| The average value of V | 0.91 | | Valid |

Based on the results of the module content validation analysis, an average value of 0.91 is obtained with the valid category. This shows that the contents of the module are in accordance with the syntax of the 5E instructional model and basic chemical law material.

Through the 5E instructional model, it is hoped that students will become active in constructing previous knowledge and connecting with new knowledge so that learning objectives are achieved and also make students become independent and work together to find concepts (Rafon & Mistades, 2020). . Through the 5E instructional model the teacher can also know and understand the obstacles experienced by students so that they can provide solutions to these obstacles (Superni, 2018).

*Implementasi*

At this stage practicality tests and effectiveness tests are carried out on the module. Practicality tests were carried out to find out the responses and comments of students and teachers in using the product. Based on the responses and comments of students and teachers, revisions were made. Analysis of teacher and student practicality data can be seen in Table 6.

**Table 6.** Module Practical Test Results on Field Test

| Rated Aspect | Teacher (%) | Students (%) | Category |
|---|---|---|---|
| Ease of use | 87.14 | 86.58 | Very Practical |
| Study time efficiency | 85.00 | 84.55 | Very Practical |
| Benefit | 88.75 | 87.19 | Very Practical |
| Average value | 86.96 | 86.10 | Very Practical |

Based on the results of the analysis of the teacher and student response questionnaires, the average scores were 86.96 and 86.10 in the very practical category. The aspect of convenience includes the ease of understanding the material in the module, the suitability of the material in the module with basic competencies, the presentation of the material in the module is arranged systematically using the 5E instructional model, and the questions presented in the competency test are in accordance with competency indicators. This is in line with the opinion that modules should not be confusing and should be easy to use (Asmiyunda et al., 2018; Syahrir & Susilawati, 2015).

In terms of time efficiency, it shows that the modules that have been developed can make students learn according to their abilities and learning speed. The 5E instructional learning model used in the module saves quite a bit of time because the stages are detailed and easy for students to understand. Therefore, the 5E instructional based chemical law module can increase the efficiency of learning time.

After the developed module is declared practical, an effectiveness test is carried out. The effectiveness test was carried out to measure students' learning outcomes and science process skills. Analysis of improving student learning outcomes for the modules developed was analyzed using N-Gain. The results of the N-Gain analysis of the sample class test learning outcomes can be seen in Table 7.

**Table 7.** Average N-Gain Score

| Class | N | Pretest Average | Posttest Average | N-Gain Average | Criteria |
|---|---|---|---|---|---|
| Experiment | 31 | 8.32 | 80.66 | 0.84 | High |
| Control | 31 | 6.97 | 85.06 | 0.79 | High |

Based on the table above, it is found that the average N-Gain is 0.84 and 0.79. From the table above it can be seen that there are differences before and after treatment in the experimental class and the control class. Increased understanding of students due to the provision of chemical phenomena at the macroscopic level and laboratory activities that make students learn and master knowledge and skills (Gambari et al., 2018; Superni, 2018).

The use of the module can affect student learning outcomes, so a hypothesis test is carried out in the control class and the experimental class. The results of hypothesis testing can be seen in Table 8.

**Table 8.** Results of Hypothesis Testing on Cognitive Learning Outcomes of the Sampe class

| Class | N | X | $S^2$ | $t_{hitung}$ | $t_{tabel}$ | Information |
|---|---|---|---|---|---|---|
| Experiment | 31 | 83.71 | 37.95 | 2.26 | 1.66 | $H_1$ accepted |
| Control | 31 | 78.74 | 24.60 | | | |

Based on Table 6, it can be concluded that the hypothesis is accepted, meaning that the use of instructional 5E-based modules can improve student learning outcomes. The 5E Instructional learning model is an approach used in scientific learning. This model is designed to stimulate student interest, develop their understanding, and promote active and deep learning (Bybee, 2014; Urifah et al., 2021).

The "Engage" stage in the 5E model is designed to capture students' attention and arouse their interest. By involving students actively in the learning process, this model encourages higher student engagement and motivation (Duran & Duran, 2004; Ong et al., 2020).

This model also allows students to actively explore concepts, conduct experiments, and develop their understanding through in-depth activities. The "Explore" and "Elaborate" stages give students the opportunity to make stronger connections between new concepts and existing knowledge. (Cakir & Guven, 2019; Salar & Turgut, 2021).

Science process skills can be seen from the ability of students to answer questions based on indicators of science process skills. The results of the science process skills test for the control class and the experimental class can be seen in the appendix which is summarized in Table 9. Based on Table 7 it is known that the average value of each indicator of science process skills in the experimental class and the control class is 85 and 80. This value indicates that the average science process skills of students in the experimental class is higher than the control class. This proves that the 5E instructional-based basic chemical law modules developed can improve students' science process skills, especially on indicators of observing, inferring, predicting, classifying and communicating.

**Table 9.** Results of Value of Science Process Capability Indicators

| Indicator | Experiment Class | | Control Class | |
|---|---|---|---|---|
| | Ave-rage | Category | Average | Category |
| Observe | 82 | High | 83 | High |
| Inferring | 88 | High | 77 | Less |
| Classify | 90 | Very High | 89 | High |
| Predict | 83 | High | 73 | Less |
| Communicate | 83 | High | 77 | Less |
| Average | 85 | High | 80 | Less |

In the "Explain" stage, students are given the opportunity to explain their own understanding of the concepts being studied. This strengthens students' knowledge construction and helps them deepen their understanding through discussions with teachers and classmates so that students' science process skills improve (Bybee, 2014; Ulukaya Oteles, 2020).

*Evaluation*

Evaluation is the final step of the ADDIE model to provide value to the teaching materials developed. In this study only formative and summative evaluations were carried out. Formative evaluation is carried out at each stage of development, for example checking material, conducting self-evaluations, and revising the design according to the suggestions given by the validator. Summative evaluation is to determine the level of achievement that has been achieved by students on teaching materials or materials that have been submitted, so that with an evaluation, the objectives of learning will be seen convincingly and accurately (Sugihartini & Yudiana, 2018).

## Conclusion

The development of basic chemical law modules based on the 5E instructional learning model using the ADDIE model. Based on the results of the analysis, the developed module is considered valid in terms of construct and content. The overall construct validity and content validity obtained an average value of 0.89 and 0.91 with the valid category. Based on the results of the teacher and student response questionnaires, the developed module is considered very practical. In the teacher response questionnaire the average practicality score was 86.96% in the very practical category and the results of the student response questionnaire obtained an average score of 86.10% in the very practical category. The results of the effectiveness test conducted in the experimental and control classes showed that the N-gain value for the experimental class was higher than the control class, namely 0.84 and 0.79. Based on the results of the t-test on student learning outcomes, it was found that $t_t < t_h$ means that the learning outcomes of classes using the 5E instructional module were significantly higher compared to classes that did not use the 5E instructional module. Therefore, it can be said that the 5E instructional based chemical law module is valid, practical, and effective. The effectiveness of the developed module is seen from the learning outcomes of students and science process skills, so that this module can already be used in the learning process.

**Author Contributions**

Fitrah Mey Harmi Siregar: preparation of the original manuscript, results, discussion, methodology, conclusions; Amalia Putri Lubis: conducting analysis, proofreading, reviewing, and editing; Rahadian Zainul: validating, reviewing and supervising; Andromeda and Budhi Oktavia: validating

**Funding**

Not Applicable

**Conflicts of Interest**

The authors declare that there is no conflict of interest regarding the publication of this paper

## References

Asmiyunda, A., Guspatni, G., & Azra, F. (2018). Pengembangan E-Modul Kesetimbangan Kimia Berbasis Pendekatan Saintifik untuk Kelas XI SMA/ MA. *Jurnal Eksakta Pendidikan (Jep)*, *2*(2), 155. https://doi.org/10.24036/jep/vol2-iss2/202

Brady, J. E., Jespersen, N. D., dan Hyslop, A. (2012). *Chemistry the molecular nature of matter. Edisi keenam*. John Wiley & Sons, Inc.

Bybee, R. (2014). Guest Editorial: The BSCS 5E Instructional Model: Personal Reflections and Contemporary Implications. *Science and Children*, *051*(08), 10–13. Retrieved from https://pimser.org/wp-content/uploads/2022/01/BSCS_5E_Instructional_Model_Bybee-article.pdf

Cakir, N. K., & Guven, G. (2019). Effect of 5E Learning Model on Academic Achievement and Attitude towards the Science Course: A Meta-Analysis Study. *Cukurova University Faculty of Education Journal*, *48*(2), 1111–1140. Retrieved from https://dergipark.org.tr/en/pub/cuefd/issue/49528/544825

Chittleborough, Gail and Treagust, D. F. (2007). The Role Of Teaching Models And Chemical Representation In Developing Mental Models Of Chemical Phenomena. *2007, Interrelationships between Innovation and Market Orientation in SMEs, Management Research News, Vol. 30, No. 12, Pp. 878-891.*, *30*(12), 878–891. Retrieved from http://hdl.handle.net/20.500.11937/763

Choirunnisa, N. L., Prabowo, P., & Suryanti, S. (2018). Improving Science Process Skills for Primary School Students Through 5E Instructional Model-Based Learning. *Journal of Physics: Conference Series*, *947*(1). DOI 10.1088/1742-6596/947/1/012021

Desouza, J. M. S. (2017). Conceptual Play and Science Inquiry: Using The 5E Instructional Model. *Pedagogies*, *12*(4), 340–353. https://doi.org/10.1080/1554480X.2017.1373651

Duran, L. B., & Duran, E. (2004). The 5E Instructional Model: A Learning Cycle Approach For Inquiry-Based Science Teaching. *The Science Education Review*, *3*(2), 49–58. Retrieved from https://eric.ed.gov/?id=EJ1058007

Elya, Z., & Maulana, R. (2022). Pengembangan Modul sebagai Bahan Ajar Manajemen Pembiayaan Pendidikan: Development of Modules as Teaching Materials for Educational Financing …. *Prospek*, *Prospek I*, 171–174. Retrieved from https://ojs.mahadewa.ac.id/index.php/prospek/article/view/1743

Farida, I., Liliasari, & Sopandi, W. (2011). Pembelajaran Berbasis Web untuk Meningkatkan Kemampuan Interkoneksi Multiplelevel Representasi Mahasiswa Calon Guru pada Topik Kesetimbangan Larutan Asam-Basa The Implementation of web-based Learning to Enhance Interconnection of Multiple Levels of Repres. *Jurnal Chemica*, *12*, 14–24. Retrieved from https://etheses.uinsgd.ac.id/9957/

Gambari, A. I., Kawu, H., & Falode, O. C. (2018). Impact of virtual laboratory on the achievement of secondary school chemistry students in homogeneous and heterogeneous collaborative environments. *Contemporary Educational Technology*, *9*(3), 246–263. https://doi.org/10.30935/cet.444108

Gita, S. D., Annisa, M., & Nanna, W. I. (2018). Pengembangan Modul Ipa Materi Hubungan Makhluk Hidup Dan Lingkungannya Berbasis Pendekatan Kontekstual. *LENSA (Lentera Sains): Jurnal Pendidikan IPA*, *8*(1), 28–37. https://doi.org/10.24929/lensa.v8i1.28

Gürses, A., Çetinkaya, S., Doğar, Ç., & Şahin, E. (2015). Determination of Levels of Use of Basic Process Skills of High School Students. *Procedia - Social and Behavioral Sciences*, *191*, 644–650. https://doi.org/10.1016/j.sbspro.2015.04.243

Hayati, N. (2016). *Keakuratan Materi Buku Teks Pendamping Bahasa Indonesia Smp Kelas Viii Kurikulum 2013*. 5–18. Retrieved from https://eprints.ums.ac.id/44310/

Lubis, A. P., Ellizar, E., Zainul, R., & Nizar, U. K. (2022). Development of Chemical Equilibrium E-Module Guided by 5E Instructional Model with Interactive Virtual Laboratory. *Jurnal Pendidikan MIPA*, *23*(1), 256–265. http://dx.doi.org/10.23960/jpmipa/v23i1.pp256-265

Manalu, J. B., Sitohang, P., Heriwati, N., & Turnip, H. (2022). Prosiding Pendidikan Dasar Pengembangan Perangkat Pembelajaran Kurikulum Merdeka Belajar. *Mahesa Centre Research*, *1*(1), 80–86. https://doi.org/10.34007/ppd.v1i1.174

Octavia, S. A. (2020). *Model-Model Pembelajaran*. Deepublish.

Ong, E. T., Keok, B. L., Yingprayoon, J., Singh, C. K. S., Borhan, M. T., & Tho, S. W. (2020). The effect of 5E inquiry learning model on the science achievement in the learning of "Magnet" among year 3 students. *Jurnal Pendidikan IPA Indonesia*, *9*(1), 1–10. https://doi.org/10.15294/jpii.v9i1.21330

Rafon, J. E., & Mistades, V. M. (2020). Interactive engagement in rotational motion via flipped classroom and 5e instructional model. *International Journal of Information and Education Technology*, *10*(12), 905–910. doi: 10.18178/ijiet.2020.10.12.1477

Retnawati, H. (2016). Analisis Kuantitatif Instrumen Penelitian. In *Academia.Edu*. Parama Publishing.

Riduwan. (2008). *Skala Pengukuran Variabel-Variabel Penelitian*. Alfabeta.

Salar, R., & Turgut, U. (2021). Effect of Differentiated Instruction and 5E Learning Cycle on Academic Achievement and Self-efficacy of Students in Physics Lesson. *Science Education International*, *32*(1), 4–13. Retrieved from https://www.icaseonline.net/journal/index.php/sei/article/view/255

Setiyaningsih, S., & Wiryanto, W. (2022). Peran Guru Sebagai Aplikator Profil Pelajar Pancasila Dalam Kurikulum Merdeka Belajar. *Jurnal Ilmiah Mandala Education*, *8*(4), 3041–3052. http://dx.doi.org/10.58258/jime.v8i4.4095

Sugihartini, N., & Yudiana, K. (2018). Addie Sebagai Model Pengembangan Media Instruksional Edukatif (Mie) Mata Kuliah Kurikulum Dan Pengajaran. *Jurnal Pendidikan Teknologi Dan*

*Kejuruan*, *15*(2), 277–286. https://doi.org/10.23887/jptk-undiksha.v15i2.14892

Sugiono. (2012). *Metode Penelitian Pendidikan*. Alfa Beta.

Sugiyono. (2013). *Metode Penelitian Kuantitatif, Kualitatif dan R&D*. AlfaBeta.

Superni, S. (2018). Pengaruh Model Siklus Belajar 5E (Engagement, Exploration, Explanation, Elaboration, Evaluation) terhadap Kemampuan Berpikir Kritis dan Penguasaan Konsep IPA. *International Journal of Elementary Education*, *2*(2), 115. https://doi.org/10.23887/ijee.v2i2.14413

Syahrir, S., & Susilawati, S. (2015). Pengembangan Modul Pembelajaran Matematika Siswa SMP. *Jurnal Ilmiah Mandala Education*, *1*(2), 162–171. http://dx.doi.org/10.58258/jime.v1i2.235

Trianto, I. B. al-T. (2017). *Mendesain Model Pembelajaran Inovatif, Progresif, dan Kontekstual*. PT Kharisma Putra Utama.

Ulukaya Oteles, U. (2020). A Study on The Efficiency of Using 5e Learning Model in Social Studies Teaching. *International Online Journal of Educational Sciences*, *12*(4), 111–122. https://doi.org/10.15345/iojes.2020.04.008

Urifah, P., Munzil, Pratiwi, N., & Yulianti, E. (2021). Interactive teaching materials using learning cycle 5E equipped with augmented reality on human respiratory system. *AIP Conference Proceedings*, *2330*(March), 2–8. https://doi.org/10.1063/5.0043274