Development of an Integrated Science Learning Module to Improve Student Learning Outcomes of SMP/MTs About Additives in Food

Pengembangan Modul Pembelajaran IPA Terpadu untuk Meningkatkan Hasil Belajar Siswa SMP/MTs Tentang Aditif dalam Makanan

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Abstract

This study aims to determine the quality of integrated science learning modules on additives and food digestion processes for SMP/MTs students. The development model used was adapted from the 4D model (Define, Design, Development, and Disseminate. This learning module was validated by one material expert lecturer and one media expert lecturer. The quality of the product was assessed by three science teachers, and ten SMP/MTs students responded. The instrument used was used in validation sheets, product quality assessment sheets using a Likert scale, student response sheets in the form of a questionnaire using the Guttman scale, and daily test questions. The assessment of module quality by three science teachers got a percentage of 90.4% with an excellent category (SB) and a response of ten students with a percentage of 85%. The results of the module trial for class VIII student learning at SMP Negeri 4 Depok, Yogyakarta, obtained a completeness percentage of 90.6% with a minimum completeness criterion (KKM) of 75. Based on these results, it can be concluded that the product developed is feasible for the learning process in SMP/MTs to improve learning outcomes.

Keywords: *Development, Module, Integrated science, Food additives*

Abstrak

Penelitian ini bertujuan mengetahui kualitas modul pembelajaran sains terpadu pada materi zat aditif dan proses pencernaan makanan untuk siswa SMP/MTs. Model pengembangan yang digunakan mengadaptasi dari model 4D (*Define, Design, Development, dan Disseminate*. Modul pembelajaran ini divalidasi oleh satu dosen ahli materi dan satu dosen ahli media. Kualitas produk dinilai oleh tiga guru IPA dan direspon sepuluh siswa SMP/MTs. Instrumen yang digunakan berupa lembar validasi, lembar penilaian kualitas produk menggunakan skala Likert, lembar respon siswa berupa angket menggunakan skala Guttman, dan

soal ulangan harian. Penilaian kualitas modul oleh tiga guru IPA mendapatkan persentase 90,4% dengan kategori Sangat Baik (SB) dan respon sepuluh siswa dengan persentase sebesar 85%. Hasil uji coba modul untuk pembelajaran siswa kelas VIII SMP Negeri 4 Depok yogyakarta diperoleh persentase ketuntasan sebesar 90,6% dengan kriteria ketuntasan minimal (KKM) sebesar 75. Berdasarkan hasil tersebut dapat disimpulkan bahwa produk yang dikembangkan layak digunakan untuk proses pembelajaran di SMP/MTs untuk meningkatkan hasil belajar.

Kata kunci: Pengembangan, Modul, Sains terpadu, Zat aditif makanan

A. Introduction

The development of Science and Technology (IPTEK) in the era of industrial revolution 4.0 brought rapid changes in various fields.[1] It has implications for education, which requires the education system to be implemented more effectively and efficiently.[2] Effective learning is learning where students can achieve predetermined learning goals.[3] A learning media adapted to the developments and demands of the times is needed.[4] According to Daryanto[5], learning media have functions including (1) clarifying messages so that they are not too verbalized, (2) overcoming the limitations of space, time, energy, and sensory power, (3) generating enthusiasm for learning, direct interaction between students and resources learning, (4) enabling students to learn independently according to their visual, auditory, and kinesthetic talents and abilities, and (5) giving the same stimulus, equating experience and generating the same perception. The existence of learning media can also improve student learning outcomes.[6]

[1] Hamdan Hamdan, "Industri 4.0: Pengaruh Revolusi Industri Pada Kewirausahaan Demi Kemandirian Ekonomi," *Jurnal Nusantara Aplikasi Manajemen Bisnis* 3, no. 2 (October 18, 2018): 1–8, https://doi.org/10.29407/nusamba.v3i2.12142.

[2] Putu Andyka Putra Gotama, "Soft Skill Dalam Dunia Pendidikan Pada Era Revolusi Industri 4.0Artikel Ini Bertujuan Untuk Mendeskripsikan Pengembangan Softskill Dalam Pendidikan Pada Era Revolusi Industri 4.0. Berdasarkan Pembahasan Diperoleh Hasil Bahwa Ada 20 Hal (Softskill) Yang d," *Jurnal Lampuhyang* 9, no. 2 (July 1, 2018): 26–39, https://doi.org/10.47730/jurnallampuhyang.v9i2.168.

[3] Punaji Setyosari, "Menciptakan Pembelajaran Yang Efektif Dan Berkualitas," *JINOTEP (Jurnal Inovasi Dan Teknologi Pembelajaran): Kajian Dan Riset Dalam Teknologi Pembelajaran* 1, no. 1 (December 13, 2017): 20–30, https://doi.org/10.17977/um031v1i12014p020.

[4] Siti Nur Azizah, "Media Pembelajaran Dalam Perspektif Al-Qur'an Dan Al-Hadits," *Jurnal Literasiologi* 6, no. 1 (July 2, 2021), https://doi.org/10.47783/literasiologi.v6i1.242.

[5] Daryanto, *Media Pembelajaran* (Yogyakarta: Gava Media, 2013).

[6] Ainun Mardhiah and Said Ali Akbar, "Efektivitas Media Pembelajaran Terhadap Hasil Belajar Kimia Siswa SMA Negeri 16 Banda Aceh," *Lantanida Journal* 6, no. 1 (July 19, 2018): 49–58, https://doi.org/10.22373/lj.v6i1.3173.

One effective learning medium to improve student learning outcomes is the module.[7] The module is an independent learning package that includes a series of planned learning experiences and is systematically designed to help students achieve learning goals.[8] The use of modules in learning has advantages, including (1) the module can provide feedback so that students know their shortcomings and immediately make improvements, (2) student performance is more focused on achieving learning objectives, (3) modules are designed to be attractive, easy to learn, and adapted to the student for increasing student learning motivation, and (4) the module is flexible, meaning that students can study the module in different ways and at different speeds. According to Pujani's[9], research results, the quality of the module learning process is very effective when applied by conducting group discussions after students previously studied the module in the form of home assignments. Therefore, the module must be arranged according to the characteristics of students so that learning objectives can be achieved optimally. One of the module preparation goals is to offer teaching materials based on the needs of the curriculum, the features of the teaching materials, the characteristics of the students, and the social environment. However, not many teachers have done learning modules according to student needs.[10]

Integrated science learning in SMP/MTs is big challenge students, teachers, and schools face. It is because the initial ability and readiness of SMP/MTs students in participating in science learning may be lacking. One of them is that there are few Science subjects in the Chemistry aspect as part of integrated science in elementary schools and are not taught by teachers with an educational background in chemistry. In addition, many chemistry materials are abstract, making it difficult for students to learn them.[11] Chemistry is a branch of natural science that studies the composition, structure, properties, and changes in matter and its energy. Chemistry would be better if given the appearance of natural phenomena or

[7] Dewi Afiyanti, "Pengembangan Media Modul Elektronik untuk Meningkatkan Hasil Belajar Mata Pelajaran Sejarah Materi Pergerakan Nasional pada Siswa Kelas XI Efektif 1 SMA Antartika Sidoarjo," *Jurnal Mahasiswa Teknologi Pendidikan* 7, no. 2 (July 21, 2016), https://jurnalmahasiswa.unesa.ac.id/index.php/jmtp/article/view/16050.

[8] E. Mulyasa, *Kurikulum Berbasis Kompetensi: Konsep, Karakteristik, Dan Impelementasi* (Bandung: Rosdakarya, 2014).

[9] Made Pujani, "Peningkatan Kualitas Perkuliahan Termodinamika Dengan Mengintensifkan Penggunaan Tes Formatif Melalui Pembelajaran Kooperatif Bermodul," *Jurnal Pendidikan Dan Pengajaran* 1, no. 12 (2006): 20–32.

[10] Uki Hares Yulianti, Nadia Gitya Yulianita, and Nisa Roiyasa, "Pelatihan Penyusunan Modul Guna Meningkatkan Kualitas Literasi Bagi Guru SMA Negeri 4 Purwokerto," *Prosiding* 10, no. 1 (April 4, 2021), http://jurnal.lppm.unsoed.ac.id/ojs/index.php/Prosiding/article/view/1383.

[11] Syaiful Bahri Djamarah and Aswan Zain, *Strategi Belajar Mengajar* (Jakarta: Rineka Cipta, 2002).

events rather than in theory. Therefore, a module is needed so that the material taught is easily understood by students.

One of the materials in junior high school that needs to be made is additives in food. Food additives are chemical substances added to food products to keep food fresh and improve its color, aroma, and texture.[12] Even the use of food additives that are not wise can cause various health problems such as allergies, sore throat, growth disorders, and even death.[13] Knowledge of additives for junior high school students is essential where students often snack around the school or home environment to choose healthy snacks to consume through the characteristics that exist in these snacks.

In this research, an integrated science module in chemistry will be developed, arranged thematically according to specific criteria. It is hoped that the module can make it easier for teachers to teach additive material to students, increase students' motivation and interest in learning, and help make integrated science learning in SMP/MTs more exciting and fun and improve student learning outcomes.

Method

This research is a research and development (R&D) research that aims to develop an integrated science learning module for class VIII SMP/MTs material additives and food digestion processes and determine the module's quality to improve student learning outcomes. The model used as the basis for developing the integrated science learning module results from the adaptation of the development of the 4-D model (four-D model) proposed by Thiagarajan (1974).[14]

The module development procedure uses a 4D development model consisting of 4 stages: define, design, development, and disseminate. The define stage collects data on needs analysis in the learning process, availability analysis, and curriculum analysis. Needs analysis is done by observing learning in the classroom and interviewing teachers, availability analysis is done by observing modules in junior high school, and curriculum analysis is related to the material contained in the media. The design stage

[12] Johnly Alfreds Rorong and Wiesje Fenny Wilar, "Studi Tentang Aplikasi Zat Aditif pada Makanan yang Beredar di Pasaran Kota Manado," *Techno Science Journal* 1, no. 2 (December 28, 2019): 39–52.

[13] Ita Emilia et al., "Pengenalan Zat Aditif Pada Makanan Dan Dampaknya Terhadap Kesehatan Di SMA Negeri I Belimbing Muara Enim Provinsi Sumatera Selatan," *Jurnal Pengabdian Kepada Masyarakat* 26, no. 2 (May 5, 2020): 65–68, https://doi.org/10.24114/jpkm.v26i2.15510.

[14] Sivasailam Thiagarajan and And Others, *Instructional Development for Training Teachers of Exceptional Children: A Sourcebook* (Council for Exceptional Children, 1920 Association Drive, Reston, Virginia 22091 (Single Copy, $5, 1974), https://eric.ed.gov/?id=ED090725.

is carried out by selecting software, collecting materials, and making the initial product design. The development stage is carried out by developing products and product validation to experts, assessing product quality to science teachers, and responding to SMP/MTs students. The dissemination stage is carried out by testing the products produced in classroom learning and then doing daily tests (UH) to determine student learning outcomes after using the module.

The procedure for assessing the integrated science learning module for SMP/MTs can be seen in Figure 1.

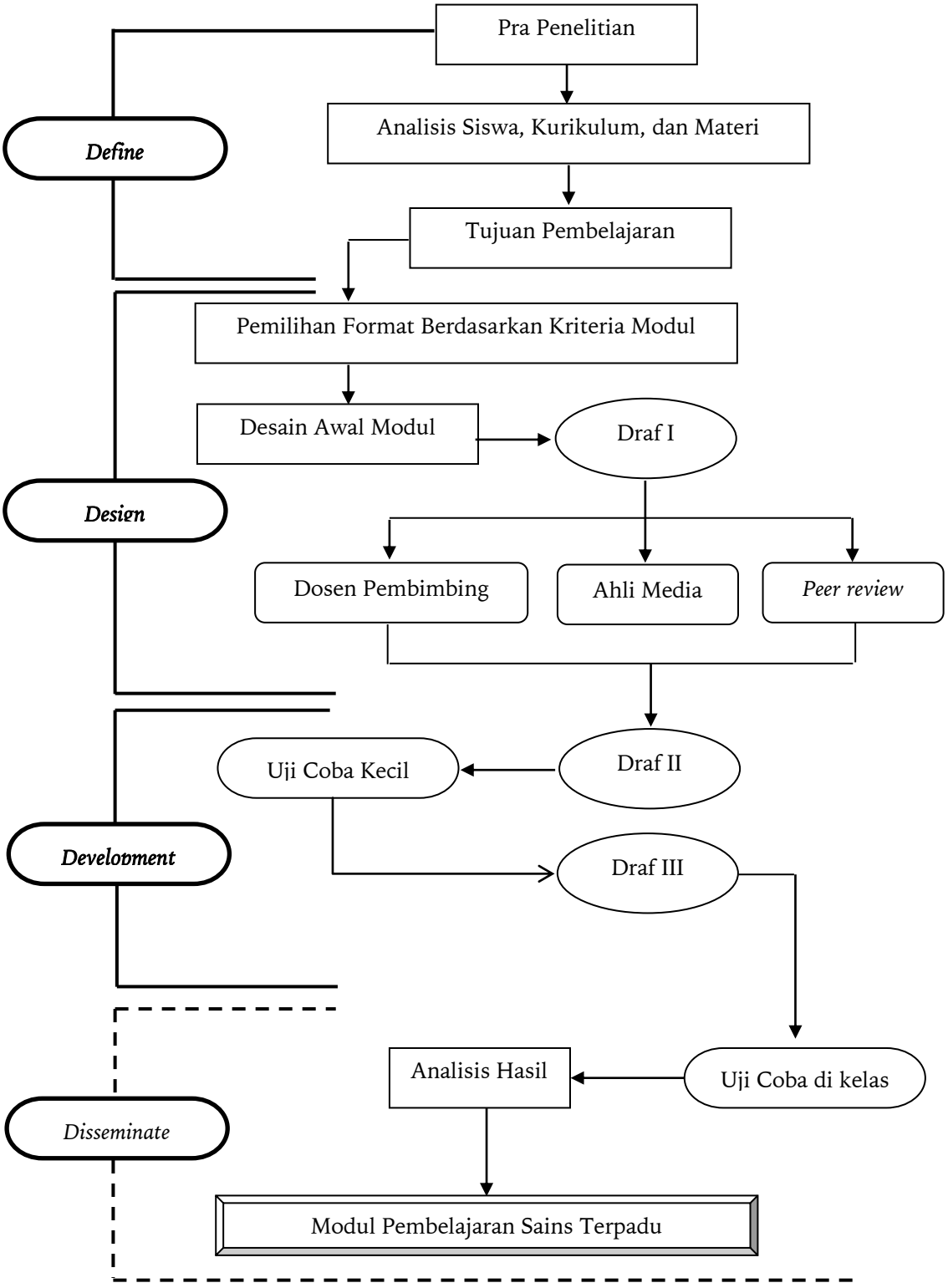


Figure 1. Product Assessment Design for Integrated Science Learning Module

The data obtained in this study were from expert validation data in the form of input and advice from material experts and media experts, media quality assessment data by SMP/MTs science teachers, student

response data, and test results daily test data (UH). The research instruments used in this study were media validation sheets, media quality assessment sheets using a Likert scale, student response sheets using the Guttman scale, and daily test questions (UH). The media quality assessment sheet consists of content feasibility, language, presentation, and visual aspects.

Data analysis techniques from the results of the integrated science module quality assessment by science teachers at SMP/MTs consist of:

1) Change the results of the product quality assessment in the form of letters (qualitative data) into scores (quantitative data) with the provisions that can be seen in Table 1 below [15]

Table 1. Scoring Rules

Description	Score
SK	1
K	2
C	3
B	4
SB	5

2) Calculate the total score from the SMP/MTs science teacher assessments for all aspects of the assessment
3) Change the average score for all aspects of the assessment and each aspect of the assessment into a qualitative value following the ideal assessment criteria with the provisions that can be seen in Table 2 below[16]

Table 2. Criteria for the Ideal Assessment Category

No	Score renge (i) quantitative	Qualitative category
	$x_i + 1.80$ Sbi $< \bar{x}$	Very good
	$x_i + 0.60$ Sbi $< \bar{x} \leq x_i + 1.80$ Sbi	Good
	$x_i - 0.60$ Sbi $< \bar{x} \leq x_i + 0.60$ Sbi	Enough
	$x_i - 1.80$ Sbi $< \bar{x} \leq x_i - 0.60$ Sbi	Less
	$\bar{x} \leq x_i - 1.80$ Sbi	Very less

4) Calculating the ideal percentage of integrated science module quality by SMP/MTS science teachers with the formula:

[15] Sugiyono, *Metode Penelitian Pendidikan Pendekatan Kualitatif, Kuantitatif, Dan R&D* (Bandung: Alfabeta, 2019).
[16] Sukardjo and Lis Permana Sari, *Penilaian Hasil Belajar Kimia* (Yogyakarta: UNY, 2008).

$$\text{Ideal percentage} = \frac{\text{achieved score}}{\text{Ideal maximum score}} \times 100\%$$

The data analysis technique from the results of the integrated science module responses by SMP/MTs class VIII students was carried out with the following steps:

1) Collect all data in the form of descriptive data obtained from student responses.
2) Change the data from student responses in the form of letters into scores using the Guttman scale with the provisions that can be seen in Table 3 below.

Table 3. Rules for Scoring Student Responses

Description	Score
Yes	1
No	0

3) Calculating the ideal percentage of responses of class VIII SMP/MTs students to the integrated science module as a whole with the formula:

$$\text{Ideal percentage} = \frac{\text{achieved score}}{\text{Ideal maximum score}} \times 100\%$$

Analysis of student learning outcomes is carried out through daily tests. The daily test results from the module trials were compared with the minimum completeness criteria (KKM) at SMP Negeri 4 Depok of 75. Then the percentage of completeness was calculated.

B. Research Results and Discussion

The result of this development research is the science module for SMP/MTs with additive material connected to the digestion of food in the human body. The module is developed through defining, design, development, and dissemination stages.

The define stage consists of needs analysis conducted through interviews with SMP/MTs teachers in Sleman, availability analysis, and curriculum analysis. Based on the interviews, information was obtained that SMP/MTs teachers in Sleman had difficulties teaching chemistry because most of them had physics or biology educational backgrounds. Availability analysis is done by observing the availability of learning modules in schools. The results of the availability analysis show that the science learning module is still very minimal. Curriculum analysis is carried out to determine the competencies developed in the SMP/MTs science module. This analysis is carried out by examining the content standards in the 2013 curriculum, which includes a study of core and essential competencies.

Based on the KD, the material's content is determined according to the primary material of additives and the process of digestion of food in the human body.

The design stage is carried out by selecting software, collecting materials, and making the initial product design. The software used in developing the media is Microsoft Word 2017 and Corel Draw X7. References include science books for SMP/MTs, general reading books, and the official website. The material in the module is in the form of dyes, sweeteners, preservatives, and flavoring agents and their relationship to the digestion of food in the human body. The initial product designs that were made were the cover, the book's layout, and the contents of the book. Cover and module layouts were created using the Corel Draw program, converted into .png format, and processed Microsoft Word. The content of the module is designed in Microsoft Word.

The developed module has several parts, including the beginning, the content, and the end. The initial part includes the cover page, introduction, table of contents, concept map, core competencies and essential competencies, the goals to be achieved by students. The concept map for the integrated science module can be seen in Figure 2 below!

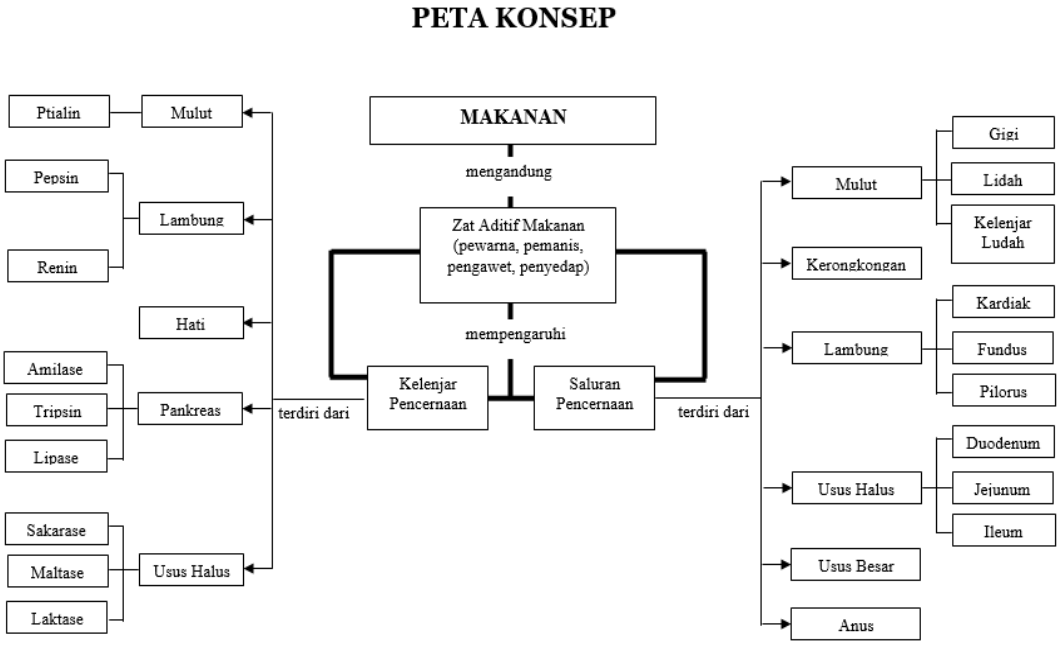
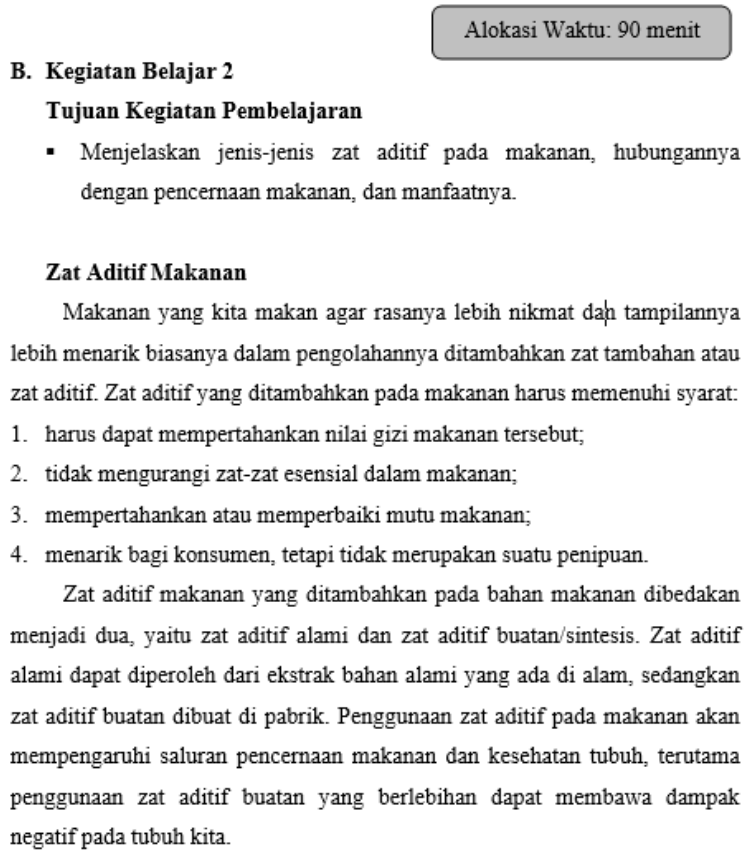


Figure 2. Concept map of the integrated science module of SMP/MTs

The concept map aims to make it easier for students to learn the material in the integrated science module of SMP/MTs Class VIII.

The content section includes material descriptions, procedures, or activities that students must follow in studying modules, mini labs,

integrated science info, practice questions, evaluations or assessments, and answer keys. The description of the material can be seen in Figure 3 below!



Alokasi Waktu: 90 menit

B. Kegiatan Belajar 2

Tujuan Kegiatan Pembelajaran

- Menjelaskan jenis-jenis zat aditif pada makanan, hubungannya dengan pencernaan makanan, dan manfaatnya.

Zat Aditif Makanan

Makanan yang kita makan agar rasanya lebih nikmat dan tampilannya lebih menarik biasanya dalam pengolahannya ditambahkan zat tambahan atau zat aditif. Zat aditif yang ditambahkan pada makanan harus memenuhi syarat:

1. harus dapat mempertahankan nilai gizi makanan tersebut;
2. tidak mengurangi zat-zat esensial dalam makanan;
3. mempertahankan atau memperbaiki mutu makanan;
4. menarik bagi konsumen, tetapi tidak merupakan suatu penipuan.

Zat aditif makanan yang ditambahkan pada bahan makanan dibedakan menjadi dua, yaitu zat aditif alami dan zat aditif buatan/sintesis. Zat aditif alami dapat diperoleh dari ekstrak bahan alami yang ada di alam, sedangkan zat aditif buatan dibuat di pabrik. Penggunaan zat aditif pada makanan akan mempengaruhi saluran pencernaan makanan dan kesehatan tubuh, terutama penggunaan zat aditif buatan yang berlebihan dapat membawa dampak negatif pada tubuh kita.

Figure 3. Description of the material for the integrated science module for SMP/MTs

The description of the material is equipped with an allocation of module learning time. The goal is that students know the time needed to study the material. The material in the module is also equipped with a mini-lab which can be seen in Figure 4 below!

Mini Lab

PENGAWET BAKSO

Tujuan

* Mengetahui bakso menggunakan boraks atau tidak dalam pembuatannya.

No.	Nama Alat dan Bahan	Jumlah
1.	Gelas minum	3 buah
2.	Alu dan lumpang	1 buah
3.	Bakso merk A, B, dan C	1 buah
4.	Larutan kunyit	Secukupnya
5.	Sendok makan	1 buah
6.	Sendok the	1 buah
7.	Label	6 buah

Langkah Kerja

1. Beri label gelas minum dengan label A, B, dan C.
2. Haluskan bakso merk A dengan menggunakan lumpang dan alu hingga halus.
3. Ambil setengah sendok teh dan masukkan ke dalam gelas minum A.
4. Masukkan air ± 5 sendok teh ke gelas minum A dan aduk hingga larut sempurna.
5. Ambil 1 sendok makan larutan dalam gelas minum A dan tetesi dengan indikator kunyit.
6. Amati dan catat perubahan yang terjadi!
7. Ulangi langkah 2 sampai 6 untuk bakso merk B dan C.
8. Isi tabel hasil pengamatan dan cobalah buat kesimpulan.

Figure 4. Minilab in SMP/MTs integrated science module

The minilab contains simple experiments conducted by students of SMP/MTs grade VIII to support understanding and depth of the concept of the material being studied. The experiment uses simple tools and materials to experiment independently at home.

In addition to the minilab, the module is also equipped with science info, as shown in Figure 5 below!

INFO SAINS TERPADU

Rhodamin B merupakan zat kimia untuk industri tekstil. Zat ini sering disalahgunakan sebagai zat pewarna kosmetik dan makanan seperti kerupuk, terasi, kembang gula, sirup, manisan, dawet, bubur, ikan asap, dan cendol. Ciri-ciri makanan yang mengandung rhodamin B antara lain warna kelihatan cerah sehingga tampak menarik dan berpendar, ada sedikit rasa pahit, muncul rasa gatal di tenggorokan setelah mengkonsumsinya, memberikan titik-titik warna, dan baunya tidak alami sesuai makanannya.

Bila mengkonsumsi makanan yang mengandung rhodamin B dalam tubuh akan terjadi penumpukan lemak, sehingga lama-kelamaan jumlahnya terus bertambah. Zat warna ini dapat menyebabkan iritasi pada saluran pernapasan dan merupakan zat karsinogenik (dapat menyebabkan kanker) serta dalam konsentrasi tinggi dapat menyebabkan kerusakan pada hati.

Figure 5. Integrated science info

Integrated science info contains information about integrating additives (chemistry) with food digestion processes (biology).

The closing section includes a summary of the material, a bibliography, and the author's identity.

The development stage involves product development and product validation to experts, product quality assessment to science teachers, and student responses. The media in the form of science learning modules that have been developed are validated for material experts and media experts. The input of the science learning module by material experts is: (1) improving the sentences used to make the language easier to understand, (2) consistency of terms and explanations of terms. Inputs from media experts are in the form of (1) images are clarified, and the size is adjusted to be proportional, and (2) improvements to the module cover, which include too contrasting cover colors and broken images.

Furthermore, the product of the validation results was assessed by the science junior high school teacher in Sleman. Assessment of media quality by science teachers consists of content feasibility, language aspects, presentation aspects, and visual aspects. The data on the results of the module quality assessment by science teachers can be seen in Table 4.

Table 4. Results of Media Quality Assessment by Science Teachers

No.	Aspek Penilaian	∑ Skor	∑ Skor Maks Ideal	Persentase Keidealan (%)	Kategori
1.	Isi	44,1	50	88,2	SB
2.	Bahasa	36,0	40	90,0	SB
3.	Penyajian	77,6	85	91,3	SB
4.	Kegrafikaan	27,7	30	92,3	SB
Keseluruhan		185,4	205	90,4	SB

The assessment results by science teachers have an average score of 185.4, with an ideal maximum score of 205 and an ideal percentage of 90.4%. Based on the assessment criteria by the science teacher, the product in the form of a science learning module is included in the Very Good (SB) category so that it is feasible to be tested on SMP/MTs students in the learning process. The science learning module that was developed was also responded to by 10 SMP/MTs students, which can be seen in Table 5.

Table 5. Results of Student Response Analysis

Aspek	∑ Skor	Skor Maksimal Ideal	Persentase Keidealan
Materi	9	10	90%
Bahasa dan gambar	8	10	80%
Penyajian	9	10	90%
Tampilan	8	10	80%
Keseluruhan	34	40	85%

The percentage of ideal products in science learning modules for material aspects, language and image aspects, presentation and display aspects is 90%, 80%, 90%, and 80%. The overall ideal percentage of 85% means that the product developed has an excellent category (SB) according to the assessment of SMP/MTs students.

The dissemination stage is carried out by testing the product in learning at SMP Negeri 4 Sleman class VIII. After learning in class using the module, a daily test is carried out at the end of the lesson. These tests are then compared with the KKM for integrated science lessons at SMP Negeri 4 Sleman of 75. The students' daily tests can be seen in Table 6 below!

Table 6. The results of the daily test of the integrated science module

No	Nilai	Ketuntasan
1	81,7	Tuntas
2	66,7	Tidak Tuntas
3	78,3	Tuntas
4	80,0	Tuntas
5	76,7	Tuntas
6	83,4	Tuntas
7	80,0	Tuntas
8	65,0	Tidak Tuntas
9	75,0	Tuntas
10	76,7	Tuntas
11	75,0	Tuntas
12	78,4	Tuntas
13	78,4	Tuntas
14	83,4	Tuntas
15	75,0	Tuntas
16	75,0	Tuntas
17	75,0	Tuntas
18	76,7	Tuntas
19	78,4	Tuntas
20	83,4	Tuntas
21	78,4	Tuntas
22	78,4	Tuntas
23	76,7	Tuntas
24	83,4	Tuntas
25	75,0	Tuntas

26	75,0	Tuntas
27	76,7	Tuntas
28	75,0	Tuntas
29	66,7	Tidak Tuntas
30	80,0	Tuntas
31	76,7	Tuntas
32	81,7	Tuntas
Rerata	76,9	
KKM	75	
% Ketuntasan	90,6%	

Based on the daily test results, it was found that the level of completeness of the students of SMP Negeri 4 Sleman after using the integrated science module for additives and food digestion was 90.6%. It can be concluded that the integrated science module can improve student learning outcomes in terms of the number of students who complete the KKM of 75.

C. Conclusion

The learning media developed in this research is the science learning module for SMP/MTs. The developed learning media has the following characteristics: (1) printed media in the form of a learning module that has a B5 size containing additive material in more depth and is equipped with practice questions; (2) the developed media is assessed by material experts, media experts, and SMP/MTs teachers. The assessment of the science teachers of SMP/MTs obtained results with a total score of 185.4 with an ideal maximum score of 205, an ideal percentage of 90.4%, and included in the Very Good (SB) category. After using the integrated science module in the learning process, the daily test results obtained a mastery rate of 90.6%. Therefore, the junior high school science module on additives and food digestion processes is appropriate to be used as a learning medium for class VIII SMP/MTs students to improve student learning outcomes.

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