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Development of a Flipbook on Functional Groups of Organic Compounds: SATLOC Approach Oriented to Science Literacy

***Ali A. Mu'minin**
Program Studi Tadris Kimia/FTIK – Universitas Islam Negeri Sayyid Ali Rahmatullah, Tulungagung – Indonesia 66221

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Abstract

The development of flipbooks for learning functional groups of organic compounds is needed to enable students to learn independently more easily and interactively. The functional groups of organic compounds have characteristics that should be realised through a systematic approach, namely SATLOC (Systematic Approach to Teaching and Learning Organic Chemistry). Based on the independent learning curriculum, the implementation of learning should emphasise the development of literacy and numeracy skills. Therefore, this research aimed to develop and assess the feasibility of a flipbook on the functional groups of organic compounds using a SATLOC approach oriented toward scientific literacy. The flipbook's development used the ADDIE (Analysis, Design, Development, Implementation, Evaluation) model. The level of product feasibility is obtained through a content validity test, including materials and media, and limited trials. The average percentage of scores for the content validity test results for materials, media, and limited trials was 88%, 85%, and 85%, respectively. These results indicate that the product is high-quality and feasible for use.

Keywords: Functional groups of organic compounds, flipbook, SATLOC, science literacy

Introduction

The implementation of learning activities requires digital technology-based facilities and infrastructure to prepare for the 21st-century digital era (Khalil & Boedihartono, 2020). One digital-based facility and infrastructure is the use of electronic modules (e-modules) as learning materials. E-modules are modules packaged in digital form and displayed on a computer, smartphone, or via the internet using links, which may include animation, video, and audio (Triyono, 2021). E-modules can be displayed in various formats, including flipbooks (Makhroji et al., 2023). Flipbooks are an e-module presentation format that simulates page-turning effects, such as those in a real book. Flipbooks are interactive because they can combine text, images, animation, video, and audio (Diani & Hartati, 2018). E-Modules in the form of flipbooks have been proven to improve students' independent learning abilities (Safitri et al., 2021).

The use of flipbooks in college organic chemistry instruction enables students to learn independently and interactively. Assari et al. (2023) showed that flipping-based e-modules can help students independently understand the acid-base properties of organic compounds. Simatupang & Sormin (2020) showed that the use of flipbook makers in chemistry instruction, particularly for hydrocarbons, is efficacious in improving students' chemistry learning outcomes. The most significant topic in organic chemistry is the study of functional groups in organic compounds. Functional groups are reactive parts in an organic compound that distinguish one compound from another (Smith, 2011; Wade, 2013; Solomons et al., 2014). Functional groups of organic compounds can be divided into three types: compounds that only consist of bonds between carbon atoms and hydrogen atoms (hydrocarbons), compounds that contain bonds between carbon atoms and electronegative atoms (N, O, halogens, etc.), and compounds that contain carbonyl groups (C=O) (Smith, 2011). The study of each functional group of organic compounds encompasses concepts such as structure, nomenclature, physical properties, and chemical reactions (Amsad et al., 2019). One characteristic of functional groups in organic compounds is their interconnectedness, as evidenced by chemical reactions that can occur within each group (Taylor et al., 2023). To that end, this study employs a SATLOC strategy focused on scientific literacy to develop and evaluate the viability of a flipbook on the functional groups of organic molecules.

*Correspondence:
Ali A. Mu'minin
e-mail: amiroell71@gmail.com

Methods

This research used the research and development (R & D) method. The development model used is ADDIE (Analysis, Design, Development, Implementation, and Evaluation). The stages of the ADDIE model in this research are: (1) Analysis stage includes activities analyzing theoretical studies, learning outcomes, learning problems, and learning materials; (2) Design stage includes activities designing instructional objectives, learning stages, product systematics, and images, animations or videos, layouts, and product formats; (3) Development stage includes activities making products; (4) Implementation stage includes activities testing product feasibility; and (5) Evaluation stage includes activities analyzing and concluding product feasibility based on criteria.

This research instrument consisted of validation sheets and a user response questionnaire using a Likert scale of 1-4, representing not good, quite good, good, and very good. The validation sheets were used to assess the validity of the product's content and media, while the response questionnaire was used for limited trials of the product. The sample for the limited product trials comprised 20 students in the 5th semester of the Department of Chemistry at UIN Sayyid Ali Rahmatullah Tulungagung. These data comprise scores from validity tests and user responses to products. The data analysis technique used in this research was quantitative descriptive analysis. Analysis of research data begins by calculating the percentage score.

$$Percentage\ Score\ (\%) = \frac{Total\ Score}{Maximum\ Score} \times 100\% \quad (1)$$

Furthermore, the percentage score is matched to the feasibility criteria referenced by Arikunto in **Table 1.**

Table 1. Feasibility criteria

Percentage Score (%)	Criteria
76 ≤ score ≤ 100	Very good
51 ≤ score ≤ 75	Good
26 ≤ score ≤ 50	Quite good
0 ≤ score ≤ 25	Not good

Results and Discussion

Product development

The development of a flipbook of organic compound functional groups using a SATLOC approach oriented toward scientific literacy was conducted in five stages, following the ADDIE model: analysis, design, development, implementation, and evaluation.

Analysis stage

In this research, the product development analysis stage was conducted to examine theoretical studies, learning outcomes, and learning problems. The theoretical analysis was conducted through a literature review and expert interviews. Learning achievement analysis was conducted for the learning outcomes of related courses and the topics studied. Learning problem analysis was carried out through observations of students who had taken the course.

A theoretical analysis, based on a literature review, was conducted of relevant research articles from several journals and books on the systemic approach to teaching and learning (SATLOC; Systemic Approach to Teaching and Learning Organic Chemistry), science literacy, and the concept of functional groups in organic compounds. Theoretical study analysis through interviews with experts was conducted on lecturers who have conducted research related to the systemic approach in chemistry learning and science literacy, have expertise or expertise in the field of literacy, especially science literacy, science literacy-oriented learning, and the independent learning curriculum of the independent campus that is oriented towards literacy and numeracy, and have expertise in the field of organic chemistry. At this stage of the development research, interviews with experts were conducted with lecturers in the chemistry education departments at UIN Sunan Kalijaga Yogyakarta, Yogyakarta State University, and Malang State University.

The analysis of learning outcomes for the courses and topics studied in this study was conducted using the lecture plan for the organic chemistry course. The functional groups of organic compounds studied in this research are covered in the organic chemistry course following the study of the basics of organic chemistry. The purpose of the analysis of course outcomes for the functional groups of organic compounds is to develop a functional group module for organic compounds that aligns with the reference and supports understanding of the concepts articulated in the course learning outcomes.

The analysis of learning outcomes of the organic chemistry course on the topic of functional groups of organic compounds was carried out in the lecture plan of the organic chemistry course of the chemistry education department of UIN Sayyid Ali Rahmatullah Tulungagung because the e-module product that will be explicitly developed will be applied in the learning of functional groups of organic compounds for students of the chemistry education department of UIN Sayyid Ali Rahmatullah Tulungagung. Therefore, in addition to analysing the course learning outcomes, the learning outcomes of graduates of the Department of Chemistry Education at UIN Sayyid Ali Rahmatullah Tulungagung are also analysed. The results of this product development are expected also to be applied to teaching functional groups of

organic compounds to students at other universities, as learning outcomes on the topic of organic chemistry functional groups are generally not substantially different.

Analysis of learning problems was conducted by observing students who had taken the organic chemistry functional group course. The purpose of observing students was to obtain more concrete information about the problems experienced by students when taking organic chemistry lectures, especially on the topic of organic compound functional groups so that the module products to be developed can be directed to overcome or not repeat these problems which of course are adjusted to the learning approach that has been studied and will be used in the development of module products. This study analysed learning problems by distributing questionnaires to students in the Department of Chemistry Education at UIN Sayyid Ali Rahmatullah Tulungagung who had taken Organic Chemistry I and II courses, with a focus on the functional groups of organic compounds. The questionnaires distributed to students were administered via Google Forms.

Based on the results of filling out the learning problem analysis questionnaire shows that: (1) most students have difficulty in learning organic chemistry in writing chemical reactions of organic compounds, (2) organic chemistry learning so far uses teaching materials in the form of material studies that have been prepared by lecturers in the form of ppt slides equipped with literature accessed from the internet, the quality of which is quite good in helping students learn, (3) most students need special teaching materials to help understand the concepts in organic chemistry, especially to overcome the difficulties, and (4) most students need issues related to the organic chemistry being studied to facilitate understanding the concepts in organic chemistry, especially about the functional groups of organic compounds. The solution to meet these students' needs is to develop teaching materials on the functional groups of organic compounds using a systematic, accessible, and engaging approach, including an e-book in flipbook format. A systematic approach can be used to overcome difficulties in writing the names of organic compounds. Organic compound reactions are characteristic of each functional group in organic compounds. According to Fahmy (2021), a systemic diagram of the relationship between chemical reactions in aromatic compounds (benzene and its derivatives) can help develop students' higher-order thinking skills (HOTS: application, analysis, and synthesis). In addition, it is necessary to develop organic chemistry teaching materials oriented toward scientific literacy to facilitate and motivate students' understanding of the functional groups of organic compounds.

Design stage

In this research, activities at the product design stage include: designing instructional objectives, designing learning activities or stages, designing the systematic flipbook of organic compound functional groups with the SATLOC approach oriented towards scientific literacy, collecting readings or articles about phenomena in life related to the concept of organic compound functional groups, and determining images, animations or videos, layouts, and flipbook formats. The design of instructional objectives consists of course learning outcomes and planned final abilities. The results of the course design, including the learning outcomes and planned final abilities, are presented in the developed flipbook.

The design of activities or learning stages in the flipbook product on organic compound functional groups, using the SATLOC approach oriented towards scientific literacy, is grounded in constructivist principles, high-level thinking skills, and science process skills, in accordance with the theory underlying the systemic approach (SATLOC) and scientific literacy. The design of activities or learning stages in the e-module or flipbook product to be developed includes: (1) problem orientation, (2) exploration, and (3) application. The problem-orientation stage includes basic questions about the concepts to be learned, guiding students to explore them more deeply. The exploration stage contains a description of the concept as a follow-up to the problem orientation given. The application stage includes practice questions on scientific literacy and higher-order thinking skills to assess students' understanding of concepts developed during the problem orientation and exploration stages.

The systematic design of the flipbook on organic compound functional groups, using the SATLOC approach and oriented towards scientific literacy, comprises an introduction, contents, and closing sections. The introduction contains the cover page, foreword, table of contents, and instructions for use. The contents section comprises chapters and subchapters on the types of organic compound functional groups and on evaluation questions for the entire chapter. The systematic design in each chapter begins with the presentation of systemic problems as chemical reaction diagrams, presented in one chapter; the relationships between reactions are not included and must be filled in by students through a series of learning activities in each sub-chapter. After the problems are presented as systemic diagrams, the learning stages of each subchapter begin with apperception, followed by orientation, exploration, and application. In the learning stages of each sub-chapter, literacy is presented on phenomena related to the sub-chapter, each with its own literacy corner. The closing section contains a bibliography and a back cover page. The systematic design of a flipbook of organic compound functional groups using the SATLOC approach, oriented towards scientific literacy, is presented as a storyboard in **Figure 2.**

Development stage

In this research, the activity at the product development stage is to create a flipbook of organic compound functional groups using a SATLOC approach oriented toward scientific literacy, based on the design developed. The first stage in creating the flipbook is to develop systemic problems/diagrams for each chapter. The second stage is to compile and present concepts in each chapter and sub-chapter. The third stage is to present a literacy corner, which is a reading about phenomena related to the concepts presented. The fourth stage is to compile evaluation questions for the entire chapter. The fifth stage is to complete the introduction and closing sections of the flipbook. The sixth stage is to present the results from the first to fifth stages as a flipbook.

The systemic diagrams in each chapter of the flipbook developed in this research present related chemical reactions. The presentation of systemic diagrams as relationships between reactions is based on Fahmy (2021), which applies systemic diagrams in SATLOC learning to the concept of benzene and its derivatives, expressed as a set of related reactions. The results of Fahmy's research show that students can learn organic chemistry with a broader perspective and context that can help develop students' thinking frameworks.

The presentation of concepts in the flipbook developed in this study is organised according to the results of the concept/material analysis conducted. Concepts are presented using constructivist learning stages: orientation, exploration, and application. The use of constructivist stages in presenting these concepts is motivated by the recognition that, in addition to the systemic approach (SATLOC), which is grounded in constructivist theory and high-level thinking skills, these stages also provide opportunities for students to construct their own concepts actively, thereby improving their understanding. According to Hitipeuw (2009), students can better understand concepts by constructing them within their cognitive structures.

The literacy corner in the flipbook developed in this study is designed to support reading about phenomena in everyday life related to the concepts presented. The purpose of the literacy corner is to improve students' scientific literacy and make learning more meaningful by presenting information that demonstrates know the concepts learned can be applied in everyday life. In addition to serving as a literacy corner, the orientation to scientific literacy in the flipbook developed in this study is presented as an application of concepts through literacy-based questions. This is done to familiarise students with reading literacy activities that improve their literacy and knowledge. Literacy is defined as the ability to understand, use, evaluate, and reflect on various types of written texts, thereby developing individual capacity and contributing productively to society (Haryani et al., 2022).

The evaluation questions developed in this research are designed to assess understanding of the concepts studied across all chapters of the flipbook. The evaluation questions created are descriptive. The purpose of presenting these evaluation questions is to assess the effectiveness of the flipbook in improving students' conceptual understanding.

The introduction and closing sections of the flipbook developed in this research were created after the SATLOC content and literacy were developed. The introduction includes: cover page, foreword, table of contents, list of tables, list of figures, and instructions for use. The closing section includes a bibliography and a back cover page. The developed flipbook product is provided as a PDF and can be viewed online or offline.

Implementation stage

In this research, the activity at the product implementation stage is to test the feasibility of the flipbook product. Feasibility is assessed through content validity testing and limited trials. The content validity test of the flipbook product developed in this research was conducted with the assistance of material and media experts. Aspects assessed by the material expert validator include aspects of content feasibility, presentation, and language. Meanwhile, aspects assessed by the media expert validator include size, cover design, and content design. The material and media expert validators in this study comprised two lecturers. The results of the product content validation by the material expert validator were an average percentage score of 88%, and by the media expert validator, an average percentage score of 85%.

The product trial was conducted on a limited basis using a research sample of 20 students from the Department of Chemistry at UIN Sayyid Ali Rahmatullah Tulungagung. The product trial was conducted across four meetings, adjusted to the flipbook's three chapters, and supplemented by completion of evaluation questions. The product trial was conducted by guiding students to study the flipbook and complete the systemic diagram and application questions. Each chapter was covered in 3 teaching hours across three meetings, and students were guided to complete the evaluation questions in the fourth (final) meeting. At the end of each meeting, students were asked to complete a questionnaire about their use of the flipbook. The results of the overall product trial indicated a strong response from students who used the flipbook developed in this research. The positive response from students was indicated by an average percentage score of 85% on the response questionnaire.

Evaluation stage

The evaluation stage in this research comprises activities that analyse the results of product feasibility tests and determine product feasibility based on predetermined criteria. The

evaluation is conducted based on the results of the content validity test and product trials during the implementation stage. The conclusion regarding product feasibility is based on the percentage criteria for the content validity test and product trials, as shown in **Table 1**. Based on the average percentage scores from the content validity test and product trials, the flipbook of organic compound functional groups developed in this study, using the SATLOC (Systemic Approach to Teaching and Learning Organic Chemistry) approach oriented toward scientific literacy, is considered highly feasible for use.

Determination of product feasibility

Based on the average percentage scores of the product content validity results from material expert validators I and II, the flipbook product developed in this research has overall met the criteria for feasibility. In terms of content feasibility, the average percentage score was 88 %. These results indicate that the flipbook product developed in this research meets the criteria of material suitability, learning outcomes, material accuracy, material up-to-dateness, and the ability to encourage students' curiosity, with very feasible criteria. In terms of presentation feasibility, the average percentage score was 84 %. These results indicate that the flipbook product developed in this research has met the criteria of conceptual coherence, student involvement, suitability with the approach used, and coherence of thought flow, with very high feasibility. In terms of linguistic feasibility, the average percentage was 93 %. These results indicate that the flipbook product developed in this research has met the criteria of straightforwardness, communicativeness, dialogicity, and interactiveness, in accordance with student development and language rules, and is highly feasible.

Based on the average percentage scores of the product content validity results from media expert validators I and II, the flipbook product developed in this research has overall met the criteria for feasibility. In terms of size feasibility, an average percentage score of 88 % was obtained. These results indicate that the flipbook product developed in this research meets the standard size and the suitability of size to content criteria with high feasibility. In terms of cover design feasibility, an average percentage score of 82 % was obtained. These results indicate that the flipbook product developed in this research has met the appearance criteria for the shape, colour, size, and proportion of images and letters, with very stringent criteria. In terms of content design feasibility, an average percentage score of 86 % was obtained. These results indicate that the flipbook product developed in this research has met the criteria for layout, typography, and illustration.

Based on the assessment and recommendations from the material and media expert validators, several improvements and revisions were made to the flipbook. Parts of the flipbook product are shown in **Figure 3.**

Following the revisions, a limited trial of the flipbook product was conducted. Based on the results of the product trial, the average student responded favorably to the product, reporting happiness rather than boredom and finding the concept easy to understand. An excellent response was indicated by the average student, who scored 3 and 4 on the assessment items in the product use response questionnaire. The student's response showed that the development of the organic compound functional group flipbook product in this study was in accordance with the principles of e-module development, namely increasing interest in learning, using flexible learning patterns, meeting learning objectives, providing opportunities to practice, overcoming learning difficulties, providing clear instructions, using a communicative and interactive writing style and language, having learning stages, providing feedback, and supporting self-assessment (Triyono, 2021).

The results of the feasibility test of the organic compound functional group flipbook product using the SATLOC approach, oriented toward scientific literacy, are consistent with those of several previous relevant studies. Rahmawati et al. (2017) showed that the flipbook learning media development product met the very valid and very feasible criteria, with an expert validation score of 86.47% and a user validation score of 81.43%. Diani & Hartati (2018) showed that the flipbook learning media product met the very feasible and exciting criteria, with expert validation scores of 95%, media expert validation scores of 90%, and small-group trial scores of 85%. Rokhim et al. (2020) showed that the flipbook learning material product met the very feasible criteria, with expert validation scores of 92.71% and 92.78%, and a product trial result of 98.30%.

The students' positive responses following use of the flipbook developed in this research indicate that it facilitates their mastery of concepts, particularly the reactions occurring within the functional groups of organic compounds. This is most likely due to the interactive flipbook and the learning approach being appropriate for the topic under study. This student's response is consistent with relevant research findings. Romayanti et al. (2020) showed that an e-module in chemistry using a flipbook is effective in developing students' higher-order thinking skills. As et al. (2022) showed, using a systemic approach affects the students' positive perception. Alwiah et al. (2018) showed that the systemic approach was effective in improving students' conceptual mastery.

The positive response from students also indicates that, indirectly, their scientific literacy has increased, as they are accustomed to encountering literacy-oriented concepts and questions in the flipbook. This is in accordance with relevant research results. Budiningsih et al. (2015) showed

that the development of scientific literacy-oriented textbooks is a valid and practical criterion for improving students' scientific literacy. Sumarmi et al. (2021) found a significant effect of flipbook worksheets on students' literacy skills. Wardhana et al. (2022) also showed that the interactive e-module is highly valid and effective in improving students' cognitive abilities related to science literacy.

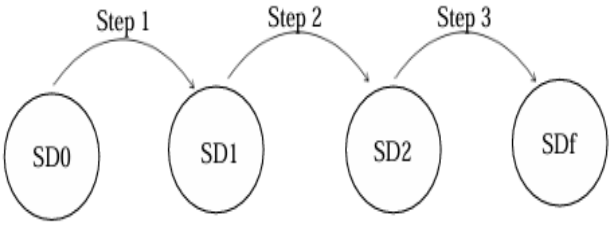

Figure 1. Step of the systematic approach (Nazir & Naqvi, 2012)

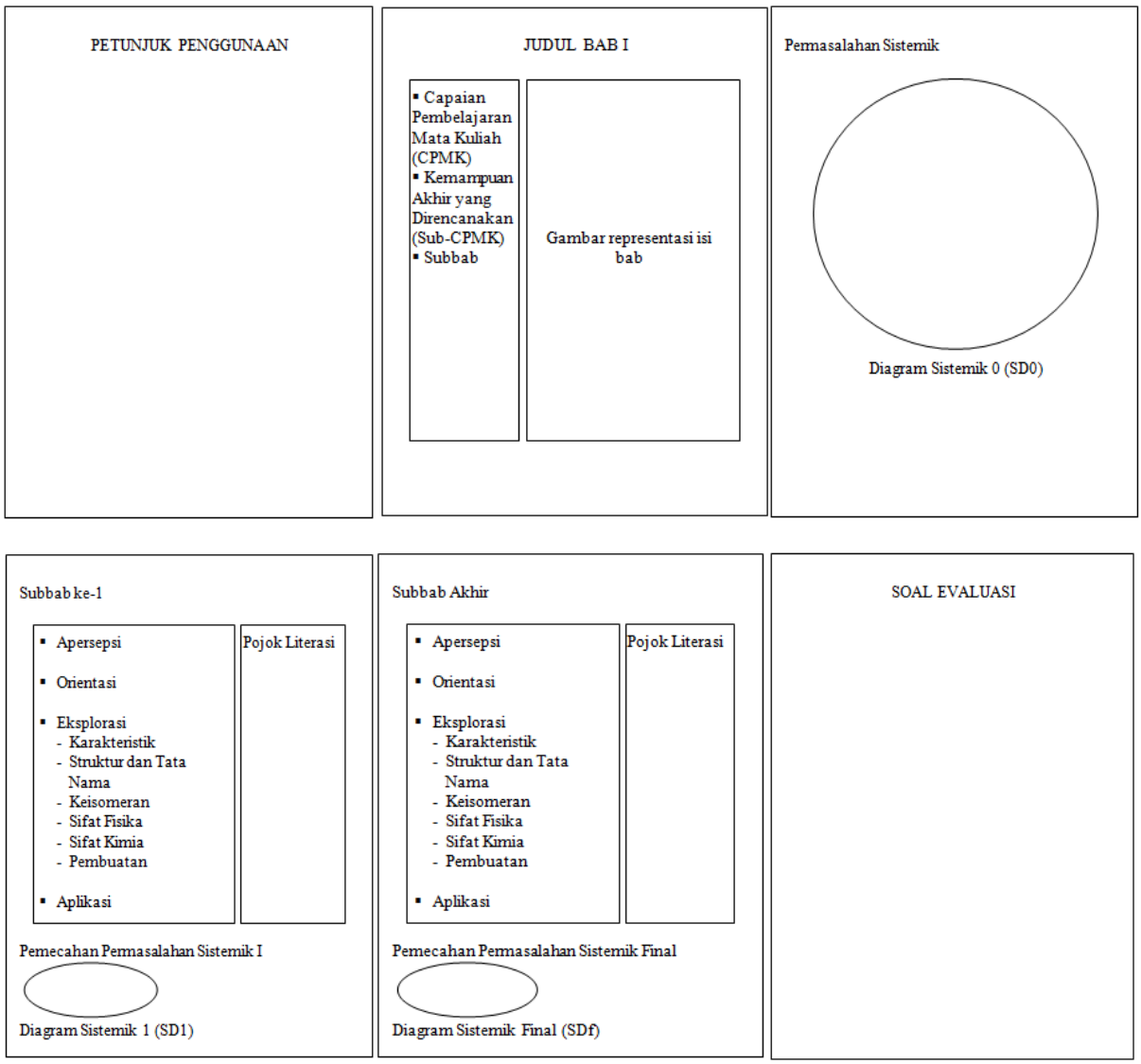

Figure 2. Storyboard of a flipbook of organic compounds, functional groups, with the SATLOC approach oriented to science literacy

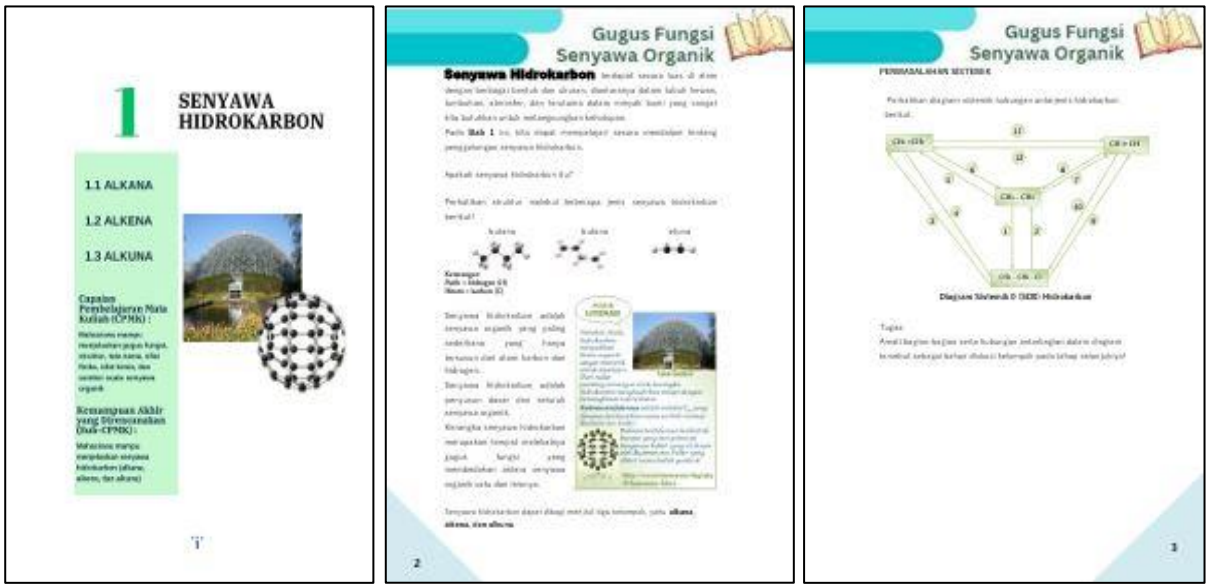

Figure 3. Parts of the flipbook product

Conclusions

The development of flipbooks on functional groups of organic compounds, using the SATLOC (Systemic Approach to Teaching and Learning Organic Chemistry) approach oriented toward scientific literacy, follows the ADDIE model: analysis, design, development, implementation, and evaluation. The level of feasibility of flipbook products is determined based on the results of the validity test of the content of the material and media, as well as limited trials with an average percentage score of 88, 85, and 85 %, respectively, which indicates that the product is included in the criteria as very feasible for use. Students reported positive responses after using this flipbook product, including that it made it easier to master concepts and indirectly increased students' scientific literacy.

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