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# Development of Interactive Chemistry Activity Book on Hydrocarbon Topics

Nicholas Noel Ferdiansyah , Natalia Diyah Hapsari 

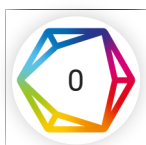
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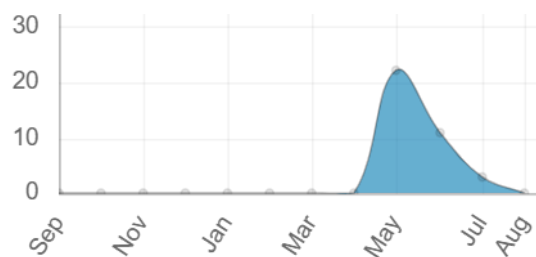
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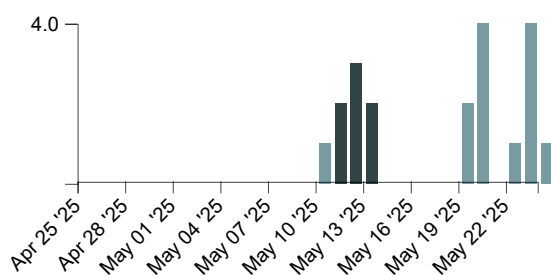
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## Abstract

The research developed an interactive chemistry activity book on hydrocarbon topics using modified 4D (Define, Design, and Develop) model. Validation by six experts yielded material and media validity scores of 0.78 and 0.80, respectively. Practicality tests involving students of SMA Negeri 1 Kalasan obtained an average score of 92.2%, and an effectiveness of as achieved at 79%. Thus, the activity book is considered valid, practical, and effective for supporting chemistry learning.

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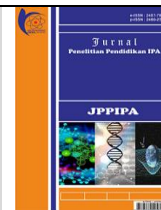
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- ☎ Phone. 081936732708
- ✉ Mail. [jppipa@unram.ac.id](mailto:jppipa@unram.ac.id)
- 🌐 Web. <https://jppipa.unram.ac.id>

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# Development of Interactive Chemistry Activity Book on Hydrocarbon Topics

Nicholas Noel Ferdiansyah<sup>1</sup>, Natalia Diah Hapsari<sup>1\*</sup>

<sup>1</sup> Chemistry Education Department, Universitas Sanata Dharma, Yogyakarta, Indonesia.

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Corresponding Author:

Natalia Diah Hapsari

[nataliadiyah@usd.ac.id](mailto:nataliadiyah@usd.ac.id)

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**Abstract:** The research developed an interactive chemistry activity book on hydrocarbon topics using modified 4D (Define, Design, and Develop) model. Validation by six experts yielded material and media validity scores of 0.78 and 0.80, respectively. Practicality tests involving students of SMA Negeri 1 Kalasan obtained an average score of 92.2%, and an effectiveness of as achieved at 79%. Thus, the activity book is considered valid, practical, and effective for supporting chemistry learning.

**Keywords:** Activity book; Development; Hydrocarbon

## Introduction

Chemistry is a natural science that is closely linked to our daily lives. However, materials in chemistry are generally abstract, graded and structured. Furthermore, chemical concepts are continuously applied to solve various problems in chemistry or to learn new chemical concepts (Kean & Middlecamp, 1985). This fact showed that students face various difficulties in studying chemical concepts. This abstract concept requires understanding high-level thinking skills (Lai, 2007).

Various methods have been developed to increase learning effectiveness and motivation. Students can be motivated by using learning media, which are available various variations. Among these are learning media in the form of games, books, pictures, objects, and so on. This is intended to arouse students' interest in dealing with learning topics (Hasanah & Sumiharsono, 2017).

One type of learning media that can be specifically developed to promote students' understanding of chemistry is the development of activity books on chemistry topics. The researchers found that no data suggested the development of activity books for higher-

level chemistry topics. Activity books are generally aimed at children with creative materials such as games, puzzles and quizzes. Activity books are usually filled with exciting illustrations, pictures and writings. In addition, the interactive capabilities of activity books can support the improvement of higher order thinking skills (HOTS) in students (Dewi et al., 2019).

One chemical material that has the potential to be effective when developed in the form of an activity book is hydrocarbon material. Based on observations, students will experience misconceptions about hydrocarbon material in the following concepts (Qodriyah et al., 2020).

Lack of optimal basic knowledge, lack of enthusiasm for learning and peer pressure are some of the causes of students' misconceptions about chemistry in hydrocarbon materials. Students develop misunderstanding based on everyday experiences, students' initial ideas, and teachers' teaching strategies (Sundaygara et al., 2021). This urgency was therefore the basis for the development of an activity book on chemistry (hydrocarbons) that was carried out.

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**Table 1.** Students' Misconceptions About Hydrocarbon Material

Concepts in Hydrocarbon Materials	Misconception (%)
Hydrocarbon compounds	22.1
Carbon atom specificity	23.6
Types of carbon atoms	22.9
Structure of hydrocarbon compounds	24.8
Physical and chemical properties of hydrocarbons	31.7
Hydrocarbon isomers	45.1
Reactions of hydrocarbon compounds	31.4

Activity books are designed to help develop students' learning skills, generally specifically for students at the elementary level. Activity books can be essential in formal education, particularly in increasing children's interest and ability in literacy by encouraging interactive reading (Merga, 2017). In addition, the skills from the presented activities are also helpful for students in improving their understanding and skills. Therefore, combining this activity book concept with abstract chemistry learning concepts is possible to help students to learn chemistry effectively and efficiently. Activity books as an interactive media involve a language approach, a literature-based reading program and an adapted program to balance reading and comprehension (Zhang et al., 2021).

Activity books have several advantages compared to other textbooks, which usually only have literary or theoretical content. Activity books as an interactive media help activate brain parts related to narrative understanding and mental imagery (Merga, 2017). Other research also states that an interactive book is needed because current conditions involving high stimulation media, especially through gadgets, are eliminating students' interest in conventional media (Wei & Li, 2023).

Aside from the improvement aspects mentioned above, the use of activity books results in student taking an active role in learning rather than just being listeners. In addition, activity books can also involve an interactive role between teachers or learning assistants and students through comments or questions about explanations not explicitly stated in the activity book. The interactive role in question refers to media as a product to which students can react so that the contained therein becomes complete or can be describe as interactive since there is a reciprocal reaction between the media and the user (Vicente, 2020). Activity books also increase students' concentration on the material because the activity books also provided engaging illustrations and narratives outside of the activities provided. The contribution of activities that increase students' participation in learning also strengthens students' understanding (Zhang et al., 2021). This active participation can be triggered by

activity books that promote awareness of reading and writing activities, monitoring the comprehension process through representative narratives and student activities (İnalçik & Angin, 2021).

Activity books have been developed for elementary school students to increase students' motivation and curiosity. Utami et al. (2023) developed a STEAM-based activity book on the topic of "Myself" for first-grade elementary school students. After learning using this activity book, the students were interested and enthusiastic. Furthermore, STEAM-based activity books were developed on Natural and Social Sciences (IPAS) learning for 5th grade elementary schools (Septiani et al., 2024). Students' curiosity increased after learning with this activity book. However, the development of an activity book based Higher Order Thinking Skills (HOTS) on Hydrocarbon material for Senior High School students has never been developed.

This study aims to describe the development of learning media in the form of Hydrocarbon activity books and determine the eligibility of the product based on valid, practical, and compelling values. The validity of the activity book is considered in two ways: material expert validity, which includes features, material and literacy aspects, and media expert validity, which includes aspects of quality, language and practicality. The practicality of the media is reflected in the results of students' response questionnaires. The effectiveness of the media is reviewed from the results of students' test scores after they are treated using the media. The eligibility of the activity book in this study are analysed by results of validity, practicality and effectiveness criteria.

## Method

Researchers conduct product development initiatives through interactive learning media like activity books. Development was carried out using the 4D model of Thiagarajan, Semmel, and Semmel (1974), which was modified into a 3D model. Thus, three main steps are carried out in the form of defining, designing and developing. The definition is carried out by conducting interviews and questionnaires regarding students' needs for the product. Subsequently, the design phase was carried out by creating an activity book based on the analysis results carried out using CorelDraw 2020® software. The results created were developed based on eligibility tests using validation, trials whose review included the results of evaluation questions, and student response questionnaires.

In this research the product was validated by 6 validators (2 lecturer, and 4 high school teachers). Product validation results are analyzed using

quantitative analysis. This data was calculate using Equation 1 (Aiken, 1985). The product that has been developed is declare valid, if the validation result obtained  $> 0.75$ .

$$V = \frac{\sum s}{n(c-1)} \quad (1)$$

Products that have been developed and received some comment from validators in the validation process. In order to determine the practically scale of the developed product, the product was tested on 30 high school students. The results obtained were analyzed using Equation 2. The results obtained were interpreted for their practicality using the criteria presented in Tabel 2.

$$P = \frac{\sum Se}{\sum Sh} \times 100\% \quad (2)$$

Note:

P : Percentage

$\sum Se$  : The number of students answer scores for each aspect.

$\sum Sh$  : The maximum score for each aspect

**Table 2.** Product Practicality Criteria (Akbar, 2015)

Score	Criteria
$81 < x \leq 100$	Very Practical
$61 < x \leq 80$	Practical
$41 < x \leq 70$	Quite Practical
$21 < x \leq 40$	Less Practical
$0 \leq x \leq 20$	Not Practical

To determine the effectiveness of the product, it was analyzed using Equation 3. The results obtained were compared with the product effectiveness criteria presented in Table 3.

$$Percentage = \frac{p}{n} \times 100\% \quad (3)$$

Note:

P : Number of scores from respondent

N : Number of score maximum

**Table 3.** Product Effectiveness Criteria (Riduwan, 2011)

Percentage (%)	Criteria
81.00-100	Very effective
61.00-80.00	Effective
41.00-60.00	Fair
21.00-40.00	Less effective
1.00-20.00	Not effective

## Result and Discussion

### Hydrocarbon Material Activity Book Validation

The product was developed refers to a modified 4D (Thiagarajan et al., 1974), turned into 3D which includes defining, designing and developing. The defining phase included the survey for students and teachers in High School in Sleman, Yogyakarta. Based on survey with teachers and students, learning chemistry has been carried out using student worksheet which contains materials dan practice questions. However, it did not contain activities that encourage students to develop concepts through specific activities. Based on these problems, the development of learning media that help students to develop concepts as a supplement to the text book.

The second phases were designing hydrocarbon material activity book. The designing of the activity book product is done by creating storyboard. Storyboard were created to make writing content and product features easier. The next step was the creating of a layout. The layout was created base on the chronology of the hydrocarbon material according to the basic competencies and indicators of competency achievement.

The content of hydrocarbon materials activity book developed consists of a glossary, an introduction, a concept map, a topic on uniqueness of carbon atoms, a topic on classification and naming of hydrocarbons, a topic on properties and reaction of hydrocarbon, and a topic on isomers and bibliography. The activity book design was created using the CorelDraw 2020® application. The product concludes with practice questions, which were also listed on the product in form of a QR code, which leads to 10 multiple choice questions that can be accessed on Quizziz page.

The product consists of material and activities. The material is presented in comic form. This comic was created from the perspective of a reader participating in the dialogue. It contains various material information about hydrocarbon materials and examples of activities performed in this product. The material content of the product are shown in Figure 1.



**Figure 1.** The material in the product

The activities contained in this product are available in various forms. The activities created relate to activities usually found in children's activity books which are modified to suit hydrocarbon material in class XI high school students. There are activities that can be completed by filling in, drawing or doing puzzles directly on the book. The product also carries out with the help of complementary media such as stickers. The activity contents of the product are shown in Figure 2.

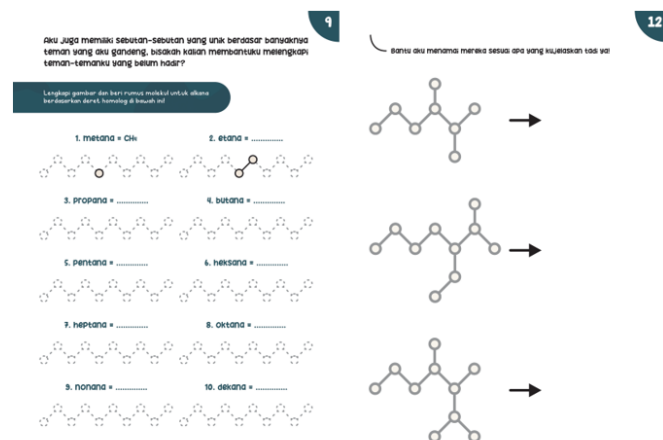


Figure 2. The activity content in the book

The product was validated by validator who assessed several aspects. The are six validators who assessed the product. The validator were lecturers and teachers in several schools. The results from validators were used as a reference at the next phase. The product validation result was analyzed (Aiken, 1985). The result of validation are shown in Table 4.

Table 4. Product Validations Result

Assessment Aspect	Value (Average)	Criteria
Characteristic	0.78	Valid
Content Material	0.78	Valid
Literacy	0.79	Valid
Quality	0.83	Valid
Language	0.80	Valid
Navigation	0.80	Valid
Total Average	0.78	Valid

Based on Table 4, the validation result was 0.78. Based on Tabel 4 (Aiken, 1985), the product has the met the valid criteria. Then product be implemented for the students. The validity of the activity book being developed is assessed by producing material concepts that are attractively packaged, yet are still supported by complete and credible hydrocarbon material information. Validity is also evident through product design and grammar efforts that do not create ambiguity and misconceptions among students. The visual design and packaging are also designed with an attractive and

quality concept. The activity book is also supported by appropriate navigation that makes it easier for students to use the activity book through a table of contents, glossary, and instructions for each activity.

The results of this study are also in line with the results of research conducted by Ananda et al. (2023), and Yusuf et al. (2020) the validity value of e-module based inquiry is above 0.75 in the material aspect. In material aspect, the activity book is arranged according to the components contained in the e-module, which consist of core competencies, basic competencies, competency achievement indexes, and learning materials (Rochmad, 2012). In the language aspect, a validity value of 0.80 was obtained, this validity value is declared valid (Aiken, 1985). The validity value of this language aspect is in line with research conducted by Putri et al. (2024) with a validity value above 0.80. The results of this validity show that the language used in the activity book is understandable to readers. The indicators used in the language aspect include that the language used was clear and easy to understand, communicative and was not use regional languages (Adelia et al., 2023).

In the next phase is product implementation. This was done to determine the practicality and effectiveness of the product that has been developed. The product was used for a chemistry learning. Then, students work on activities based on the activities contained in the product. Next, students fill out a questionnaire containing the practicality of the product that has been developed. The result of practicality of the product are presented in Table 5.

Table 5. Product Practicals Results

Aspects	Value (Average)	Category
Quality	89%	Very Good
Motivation	90%	Very Good
Language	89%	Very Good
Appearance	97%	Very Good
Clarity	94%	Very Good
Benefit	94%	Very Good
Total Average	92.2%	Very Good

Based on Table 5, the results show that the developed product has practical criteria with an average score of 92.2%. The value obtained is very high, this means that the product has very good quality in motivation, language, appearance, clarity, and benefit. The assessment results given by students show that the product developed is interesting (Ratnasari et al., 2023). Learning with interesting media and various activities can increase students' creativity (Martono, 2021).

The product was developed are implemented in the learning process at SMA Negeri 1 Kalasan. Students learned Hydrocarbon material by using products that



have been developed, then students answered questions about hydrocarbon materials. The aims of this activity are to determine the effectiveness of the product that have been developed. The effectiveness of the product is 79% percentage in effective (Riduwan, 2011), the product was attractive, easy to earn and can stimulate students' interest in learning. These results show that activity books are effective, students managed to achieve an average score of 79% by applying the knowledge acquired in their learning sessions using activity book media. This effectiveness value is lower compared to the use of hydrocarbon e-modules in chemistry learning (Kartikasari, 2021). In the Hydrocarbon e-module, the learning material is presented in a complete and structured manner (Safitri et al., 2022). Students feel more comfortable when the information is presented completely (Canboy et al., 2016).

The effectiveness value of using activity books is almost the same as the effectiveness value of using e-modules integrated with HOTS (Adella & Dalimunthe, 2024). The use of HOTS-based modules can improve students' critical thinking skills compared to the use of conventional textbooks (Sugiharti et al., 2024). HOTS-based learning encourages students to be active in every learning activity (Retnawati et al., 2018). Activity books stimulate student activity by providing material input that can be accessed independently, and the form of games presented stimulates students' fun, motivation, adrenaline, excitement, creativity, and emotion so that they can help them learn hydrocarbon as a new learning material more effectively than conventional learning methods (Vandercruysse et al., 2012).

## Conclusion

Based on the research conducted, the following conclusions were drawn. Development of interactive chemistry media products: Activity Books on Hydrocarbon Materials can be carried out using 3D models. The results of developing interactive chemistry media products: Hydrocarbon Materials activity books have appropriate value for use as learning media. Feasibility is reviewed from the validation, practicality, and effectiveness values. From the results of product validation research by material experts, it is known that it has a valid value with a validity value of 0.78. The results of the product validation by media experts show a valid value of 0.80. Effectiveness is obtained by the average score of students on material assessment questions, namely 79%, indicating that students have achieved effective criteria for understanding hydrocarbon material. Also, practical applicability is obtained from students' very positive responses to the product through student response questionnaires with

an average score of 92.2%. Future studies are recommended to apply the activity book in various chemistry topics and conduct longitudinal studies to assess its long-term impact on conceptual understanding.

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## Author Contributions

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## Conflicts of Interest

No conflict interest.

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