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DESIGNING A CHEMO-ENTREPRENEURSHIP PRACTICAL INSTRUCTION IN THE TOPIC OF MACROMOLECULES

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ABSTRACT

The CEP approach combines chemical knowledge with entrepreneurial concepts. In the manufacture of macromolecular products, a deep understanding of chemistry is essential. Entrepreneurship education is very important because it raises enthusiasm and motivates students to start a business when they graduate from school. The research objective is to design practical instruction for Chemo-Entrepreneurship (CEP) focusing on the subject of macromolecules. The type of research used for the development of practical instructions in this study is Research and Development. The development method is ADDIE (Analysis, Design, Development, Implementation, and Evaluation). The product developed was validated by six validators in the valid category according to Aiken's V table with a validity value of 0.846. The research subjects in the product trial developed in this study were students of class XII MIPA SMAN 1 Cepu. The assessment of student responses was in the very good category with a percentage of 94.3%. It can be concluded that the CEP-practical guide is feasible to use. The resulting product is expected to be used as a learning resource on the macromolecule topic.

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Introduction

The purpose of education is to develop students' self-potential essentially aims to educate and improve human resources so that they can have a decent life (Cantor, 2021). In Indonesia, the goals of education are stated in the curriculum that applies to education in Indonesia, namely the Merdeka Curriculum. The Merdeka Curriculum pays attention to increasing faith and piety, Pancasila values, increasing noble morals, increasing the potential, intelligence and interests of students, diversity of regional and environmental potential, regional and national development demands, demands of the world of work, developments in science, technology and the arts; religion; dynamics of global development; and national unity and national values (Kemendikbudristek, 2022). The main aspects that determine the success of the learning process are students, teachers, and learning resources or teaching materials (Cooper & Stowe, 2018). The teacher acts as a facilitator in learning, students act as parties who are the subject of learning, and the media acts as a tool or intermediary for teachers in delivering material to students. If the three influential aspects in it support each other, teaching and learning activities can run well (Hakim & Zammi, 2020).

In the high school curriculum, students are exposed to the fascinating realm of chemistry, a subject that delves into the structure, composition, and reactions of substances. Chemistry lessons require students to be able to appreciate and master a collection of knowledge in the form of the truth of chemical concepts or principles (Akram et al., 2017; Najib & Misrochah, 2020). Chemistry is the study of phenomena that occur in matter and the origin of matter and the changes that accompany them in natural processes and experiments (Keenan et al., 2001). Laboratory experiments make theoretical information in chemistry verifiable (Agustian et al., 2022). Therefore, the process of learning chemistry is not only through understanding the theory from books but also through experiments that can be directly related to various objects that are useful for human life (Hofstein & Hugerat, 2021). Practical activities in the laboratory can also provide opportunities for students to have experience or practice themselves, follow a process, observe an object, examine the information and determine conclusions from a condition or a process (Adams, 2020).

Macromolecule material is not only

theoretical but also close to human life. Macromolecule material is theoretical which includes the subject of structure, nomenclature, properties, use, and classification of polymeric macromolecules, carbohydrates, proteins, and fats. The material connects each concept to the subject so that it seems abstract. Students experience difficulties in absorbing abstract chemical concepts (Saragih et al., 2021). However, based on the results of the analysis of source books and interviews conducted by researchers at SMAN 1 Cepu, shows that the chemistry learning applied to Macromolecule material does not match the existing learning outcome. The learning carried out only focuses on cognitive domain which contains the realm of knowledge only. In senior high school curriculum, it is stated that the learning outcome that students must have been analyzing the results of searching for information about the produce and impact of a product from macromolecules contained in learning outcome.

The results of interviews conducted by researchers at chemistry teachers at SMAN 1 Cepu showed that experiment on macromolecules had never been done. Experiment conducted at school on certain materials, namely elements of group 1A, 2A, and colligative properties of solutions. An experiment on macromolecule material was not carried out because it was considered to have been discussed in biology subjects. However, considering the existence of learning outcome in macromolecule material, experiment activities that hone students' skills should still be carried out. Thus, following the curriculum competencies, researchers are interested in designing practical instructions for making chemical products to support learning outcome which is still rarely developed.

Teaching materials in the form of innovative practical instructions are expected to be able to improve the quality of education and human resources that can compete with technological developments (Mardhiya et al., 2020). Learning support innovations to provide a more meaningful learning process to improve the quality of education and human resources can be circumvented by combining Chemo-Entrepreneurship (CEP) oriented chemistry experiments (Dewi & Mashami, 2019). The CEP approach is following chemistry experiment by linking theory with real objects (Rahman et al., 2020). Thus, students can absorb the theory they understand, hone their talents, and increase creativity in processing material into a product that is useful and has economic value

(Drastisianti et al., 2018). Based on research Rahmawanna (2016) states that the use of CEP in chemistry learning can affect the positive nature and entrepreneurial interest of students in chemistry lessons.

The CEP approach combines chemical knowledge with entrepreneurial concepts. In the manufacture of macromolecular products, a deep understanding of chemistry is essential. However, the ability to apply this knowledge in a business context is also necessary, and that is what the entrepreneurial aspect emphasizes (Ni'mah & Suwardi, 2023). CEP-oriented learning aims to instill a person's spirit, enthusiasm, values, and character to survive and provide benefits to the environment (Sadraei et al., 2018). Creativity, innovative, honest, responsible, and willingness to take risks for greater opportunities are also important for students to have (Rahman et al., 2020). This is under the opinion conveyed by the Secretary General of the Ministry of Education and Culture (2021) that the market will continue to grow until 2045, so students must understand entrepreneurship so that they are not left behind during rapid world development. Efforts to prepare high school students to become quality graduates and have entrepreneurial skills are needed, so they can compete with the world of work in Indonesia. Entrepreneurship education is very important because it raises enthusiasm and motivates students to start a business when they graduate from school (Ni'mah & Suwardi, 2023). Based on the considerations and observations that have been made by the author, it is necessary to develop a CEP practical guide that can support chemistry learning through experiment on macromolecule material.

Research Methods

The type of research used for the development of practical instructions in this study is Research and Development (R&D). The R&D method is a research method to produce a product and at the same time test the effectiveness of the product (Sugiyono, 2010). The development model adopts the ADDIE model developed by Molenda, namely analysis, design, development, implementation, and evaluation (Molenda, 2003). The researcher chose the ADDIE model because the five stages of the development model were interrelated and arranged systematically. Each stage goes through an evaluation process to reduce errors in product development.

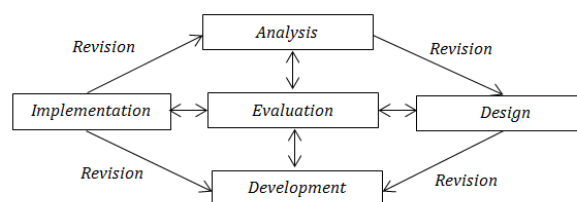


Figure 1. ADDIE development model

The object of this research is the CEP practical guide of macromolecule products for class XII science high school. The test subjects in this study were 6 product validators consisting of media and material experts, and learning practitioners. Validation of research instruments is done by asking for expert judgment. The data collection instrument used in product validation is a 5-scale validation sheet which is analyzed using Aiken's V formula. The following is Aiken's V formula:

$$V = \frac{S}{[n(c - 1)]} \quad (\text{Aiken, 1980})$$

Note :

- S = sum of s of every n
- s = r - lo
- lo = lowest validity value (score 1)
- c = the highest validity value (score 5)
- r = value given by validator (experts)
- n = number of validators

Another test subject is 33 students of class XII IPA SMAN 1 Cepu who will do a experiment using the CEP-oriented experiment guide product. The data collection instrument used to see the feasibility of the experiment was a statement questionnaire with yes/no answers with a scoring rule of 1 for yes answers and 0 for no answers. The data obtained is then calculated using the following formula:

$$\text{Score (\%)} = \frac{\text{overall score}}{\text{max score}} \times 100\%$$

Table 1. Practical guide eligibility category

Value	Criteria
86-100%	Very good
76-85%	Well
56-75%	Enough
55-59%	Not enough
0-54%	Not much

Result and Discussion

The stages of development are following the ADDIE method, namely analysis, design, development, implementation, and evaluation (Sukardi, 2004). The following is a description of the development stages according to the ADDIE

method:

1. Analysis

Stages of analysis are carried out to identify problems that occur during chemistry learning at SMAN 1 Cepu. Stages of analysis in this study carried out several steps of analysis as follows surroundings, student needs, and topic. Analysis of the surroundings was carried out by observation and interviews at SMAN 1 Cepu. Environmental analysis using the interview method was conducted on chemistry teachers to obtain information about the environment and chemistry learning methods. The learning carried out during Covid-19 is Distance Learning (DL). Chemistry experiments are rarely even carried out because during DL, face-to-face learning is not allowed in the classroom or the laboratory. It takes teaching materials that support the implementation of experiments that can be used during face-to-face learning at school and during DL at their respective homes that make it easier for students to absorb information about chemical products that are useful and have economic value.

Based on the results of interviews with students, information was obtained that students had difficulties understanding abstract Macromolecule chemistry. However, students can more easily understand chemical material if it is associated with experiment and examples of the use of chemistry in products that have economic value. Students are interested in conducting CEP-oriented experiment on Macromolecule chemical products. Teaching materials according to student needs based on this analysis are CEP-oriented experiment manuals that can be used independently during DL.

The selection of macromolecules based on the previous analysis showed that students had difficulties understanding Macromolecule material. Macromolecule material has 2 BC namely knowledge and skills. The chemistry teacher at SMAN 1 Cepu mentioned in the interview that learning about macromolecules only focuses on the knowledge aspect, while the skill aspect is still not paid attention to.

2. Design

The design stage is divided into the four step there are Data collection, Selection of Practical instructions content, design application selection and selection of product print form. Data collection at this stage is carried out to obtain data in the form of materials and images according to the needs that underlie the development of a CEP-oriented experiment manual. Data were obtained from a literature review of chemistry books, research journals, and various other sources.

The CEP experiment manual includes three

types of experiment with the main material for making products from macromolecules. The content contained in the practical instructions is: editorial, preface, table of contents, procedures for implementing chemistry experiment, laboratory rules, work safety symbols, chemical laboratory equipment, core competencies, basic competencies, and indicators, macromolecule material, practical instructions on manufacture of polymer products: "Softcase Resin Crafts", practical instructions for making fat products: "Making VCO (Virgin Coconut Oil)", practical instructions for making products.

Design practical instructions using the Canva website to produce an attractive display of practical instructions as a learning medium. The choice of Canva as a design platform is because according to (Rahmasari & Yogananti, 2021) Canva is one of the best design platforms available on websites and applications. The final product is stored in a PDF so that the print is not blurry and printed in the form of an A5 size experiment manual using 230-gram art carton/ivory paper with hard paper lamination. The paper was chosen because it is lighter to use as a printed book.

3. Development

At this stage, the product is the result of the initial design which will then be tested for validity. In addition to the validity test, at this stage, a revision is also made according to the suggestions from the validator. The validator provides an assessment based on the assessment sheet and assessment rubric that has been given. The validator can also provide criticism and suggestions in the column provided on the assessment sheet. The results obtained from the validator's assessment are then calculated based on Aiken's V index. The results of the validation calculations can be seen in the following table:

Table 2. Expert validation results

Aspect eligibility	Validity Value	Results
Content	0.865	Valid
Linguistic	0.854	Valid
Serving	0.833	Valid
CEP	0.833	Valid
Average	0.846	Valid

The results of the validity given by the six validators obtained an average of 0.846 or in the valid category. Based on the results of the assessment from the validator, the product is declared valid and can be used after making revisions according to the criticisms and suggestions were given (Islamiati et al., 2020).

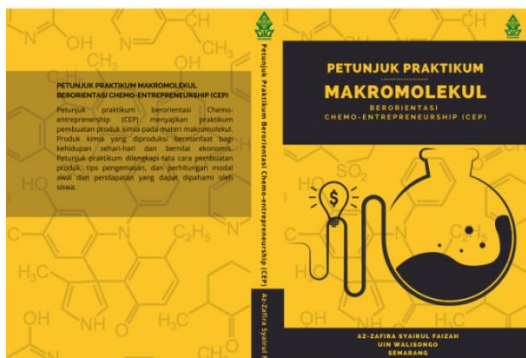


Figure 2. Final product cover

The product contains macromolecule

Table 3. Chemo-Entrepreneurship (CEP) Practical Instructions on the Topic of Macromolecules

Indicator	Title	Final Product
Implementing experiments on the manufacture of polymer macromolecule products	Experiment 1: Making Resin Crafts	
Implementing experiments on the manufacture of carbohydrate macromolecule products	Experiment 2: Making Hard Candy	
Implementing experiments on the manufacture of fat macromolecule products	Experiment 3: Making Virgin Coconut Oil (VCO)	

material related to the meaning of macromolecules, types of macromolecules, and examples of macromolecules in language that is easy to understand. Each material discussed is complemented by practical work on making Macromolecule products that have economic value. Polymer, carbohydrate, and fat experiment according to the indicators to be achieved. Each experiment is equipped with experiment objectives, tools and materials, work procedures, observation sheets, product packaging tips, and an analysis of capital and entrepreneurial profits.

4. Implementation

The implementation was carried out on 33 students of class XII IPA 4 at SMAN 1 Cepu to test the implementation and use of the practical instructions. After students understand and carry out experiment using the developed practical instructions, students are asked to provide an assessment through student response questionnaires. The questionnaire consists of 17 statements related to physical appearance, linguistics, implementation, utilization, and CEP. Student assessment of the product will be used as a basis for evaluation at a later stage for the improvement and refinement of the resulting product (Tegeh et al., 2014). Through filling out questionnaires, students can provide assessments and suggestions regarding the products developed.



Figure 4. Experimental products (a) soft case resin (b) hard candy (c) VCO

Table 3. The percentage of student responses

Aspects	Presentage (%)	Average (%)	Criteria
Physical appearance	100		
Linguistics	97		
Implementation	88.64	94.30	Very good
Utilization	97		
CEP	92.70		

The average percentage in all aspects is 94.30%. The percentage of student responses indicates that students can use the product developed in a very good category (Purwanto, 2010).

5. Evaluation

The evaluation stage is carried out at each stage of product development to obtain maximum results and reduce errors that occur. The evaluation used is formative. At this stage, the researcher reviews the product based on suggestions and input from the validator during the validation process. Suggestions from learning practitioners who accompany the implementation process are also used as evaluation materials for the products developed. Using CEP-oriented practical instructions on macromolecule material makes students more interested in studying chemistry. Following the opinion (Prayitno et al.,

2015) that learning with the CEP approach can turn students into more active participants in learning, creative in analyzing problems and making products, practicing entrepreneurship by calculating profits/losses, and daring to offer product results that have been they produce. The use of CEP can also improve aspects of students' life skills, including communication skills, collaboration, use of tools, work discipline, and better work attitudes.

Macromolecules practical instruction based on CEP can be an innovative solution to challenges in education and industry (Rahman et al., 2020). Combining knowledge in chemistry and entrepreneurship can enable students to produce products that can be sold (Murni et al., 2018). The integration of chemistry and entrepreneurship will open the door to students' creative ideas and provide a positive, sustainable impact.

Conclusion

The practical instructions for Chemo-Entrepreneurship (CEP) focusing on macromolecules cover experiments related to the production of polymer, carbohydrate, and fat macromolecule products. The validation process involved six validators, resulting in an average validity score of 0.846, indicating that the instructions are in the valid category. The overall student response to the product was highly positive, with an impressive average percentage of 94.30%. This suggests that students found the practical instructions to be of very good quality, supporting the conclusion that the developed CEP guide for macromolecules is both valid and well-received by students.

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