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Development of Chemistry Magazine Containing Content on Cross-Aldol Condensation Reaction as Reading Material for Polyfunctional Organic Compounds Lectures

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Abstract: Chemistry magazines have the potential to be effective media because they are able to present material in a more interesting, concise manner, and are supported by visualizations that clarify abstract concepts. The use of chemistry magazines is expected to help students deepen their understanding of the aldol condensation reaction mechanism and other organic materials. This study aims to develop a chemistry magazine that contains content on the cross-aldol condensation reaction mechanism as a supplementary reading for students in the Polyfunctional Organic Compounds course. The type of research used is research and development (R&D) with a 4D model that includes the stages of define, design, develop, and disseminate. The subjects of the study were students from the Chemistry Education Study Program at the University of Mataram, while the object of the research was a chemistry magazine developed based on the results of a student needs analysis. Data were collected through expert validation sheets and student response questionnaires, then analyzed descriptively and quantitatively using Aiken's V formula to measure validity and percentage of agreement (PA) to measure reliability. The results showed that the chemistry magazine obtained an average validity score of 0.93, categorized as "highly valid," and a reliability level of 94%, categorized as "reliable." Meanwhile, the results of the practicality test, as obtained by students, achieved a percentage of 85% with the category "very practical". Thus, the chemistry magazine developed is declared feasible and practical for use as additional reading material to enhance students' understanding of the cross-aldol condensation reaction mechanism in the Polyfunctional Organic Compounds course and to foster an interest in learning chemistry independently.

Keywords: Chemistry Learning; Chemistry Magazine; Cross-Aldol Condensation.

Introduction

Chemistry is a branch of natural science that studies the properties of matter, its structure, changes in matter, and the energy involved in chemical reactions. Chemistry is taught starting in high school and studied in greater depth in college [1]. One branch of chemistry studied in college is organic chemistry. Organic chemistry courses study the structure, properties, composition, reactions, and synthesis of organic compounds, playing a crucial role in life, as most products in society contain organic compounds [2]. The chemistry education study program at Mataram University offers a series of organic chemistry courses, including Monofunctional Organic Compounds, Polyfunctional Organic Compounds, and Mechanisms of Organic Compound Synthesis.

One of the important topics in organic chemistry courses is how to synthesize organic compounds and the mechanisms involved in these reactions. Therefore, one of the topics covered in organic chemistry courses is the study of polyfunctional organic compounds. The Polyfunctional Organic Compounds course is a compulsory advanced course. Students who have completed this course are expected to be able to explain how to synthesize organic compounds and the mechanisms involved. The Polyfunctional Organic Compounds course provides an in-depth discussion of the chemical reactions that occur in organic compounds. The main material studied includes organic reaction mechanisms, such as the stages that molecules undergo during chemical reactions, including various types of reactions, including substitution, elimination, and addition. This course also explores the role of functional groups and the stability of intermediates, including carbocations, carbanions, and free radicals. In this course, students learn about the reactivity of organic compounds, functional group interactions, conformational analysis, and stereochemistry to gain a deeper understanding of the synthesis process of organic compounds [3].

Organic compound reactions are reactions that occur in organic compounds involving the transfer of an atom and producing a new type of organic compound structure [4]. Reactions in organic chemistry encompass several different types, including addition, elimination, substitution, peroxidation, condensation, and other reactions. These reactions are typically employed to convert one organic compound into another [5]. Condensation reactions are processes in which two or more molecules combine to form a single, larger molecule, often accompanied by the release of small molecules such as water, ethanol, or ammonia. Condensation reactions are also known as dehydration reactions because they involve the release of water molecules [6]. An aldol reaction is an organic condensation reaction between two carbonyl compounds (aldehydes or

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ketones) that have an α carbon atom (the carbon next to the carbonyl group) with α hydrogen [7]. Aldol condensation reactions occur in an acidic or basic environment, which then produces β-hydroxy carbonyl compounds [8]. This type of reaction is called an "aldol" reaction because the initial products are an alcohol and an aldehyde or ketone [9]. In other words, aldol condensation combines two carbonyl molecules, such as aldehyde or ketone, into a more complex molecule, which contains aldehyde and alcohol groups in their initial form [10].

Based on the survey results, students stated that polyfunctional organic compounds are still taught using methods that are not very interactive, and students are only taught theory without accompanying practical activities in the laboratory, making it difficult for students to understand the material, especially in understanding the types of reactions, reaction mechanisms, and organic compound synthesis. The survey results show that most students still do not fully understand the material on aldol condensation reaction mechanisms in polyfunctional organic compound lectures. Students stated that they had difficulty understanding the stages of each reaction mechanism that occurs in the synthesis of organic compounds. The difficulties experienced by students indicate the need for additional media that can help clarify concepts that are difficult to understand. Learning media is significant and very effective because it can foster students' interest in learning.

The use of learning media can be utilized in systematic learning activities from educators to students to maintain active classroom learning activities. A person who is learning needs visual or verbal assistance to make it easier to understand the material being studied [11]. One of the media considered interesting to use is Chemistry Magazine. Magazines are print-based media that contain content accompanied by images, packaged in an attractive way and presented in a clear and straightforward manner to make them easier to understand. In addition to content, magazines can also contain educational information that broadens knowledge [12]. Magazines also have advantages, such as specially created themes, regular publication, covers designed to be as attractive as possible to prevent reader boredom, complete information, and clear images and photos [13].

The survey results indicate that 96.7% of students are interested in using chemistry magazines as a learning medium. The use of chemistry magazines as learning media is considered to help students understand complex material. Chemistry magazines are considered capable of presenting material in a more interesting and concise manner, complete with visualizations in the form of pictures and illustrations that support understanding and increase interest in learning. Additionally, the flexible and interactive presentation makes students more enthusiastic about learning the material, without relying entirely on traditional classroom learning methods. With chemistry magazines, students hope to deepen their understanding of abstract and complex chemical concepts, especially regarding the mechanism of aldol condensation reactions in organic compounds.

Several previous studies have discussed the aldol condensation reaction and the use of chemistry magazines as a learning medium. One of them is research on the aldol condensation reaction in the context of green chemistry-based science learning, where the research emphasizes the importance of environmentally friendly synthesis through the use of alternative solvents in practicums, but has not presented it in the form of reading media such as magazines [14]. Other studies focusing on the development of chemistry magazines have also been conducted. Some of these include research on the development of chemistry magazines that focus on FTIR and GC-MS instrument analysis to identify chalcone compounds, so that the resulting magazines emphasize spectral interpretation [15]. In addition, the development of chemistry magazines that include GC-MS analysis of renggak leaf extract as supplementary reading material for students has also been undertaken [16]. However, to date, there has been no research on the development of chemistry magazines that integrate the concept of synthesis and the mechanism of cross-aldol condensation reactions designed as additional reading material for students. Therefore, the development of magazines containing cross-aldol condensation reactions as reading material in Polyfunctional Organic Compounds lectures is necessary.

The gap between students' expectations and the actual conditions in the field requires a solution that can bridge the gap between lecture outcomes in the form of students' understanding and skills in mastering Organic Chemistry material. One solution that can be implemented is the provision of integrated teaching materials that combine theoretical material, practical activities, and their application in one teaching medium, namely a chemistry magazine. The chemistry magazine contains theoretical material combined with laboratory activities and relevant supporting content. Considering that the organic chemistry course in the Chemistry Education Study Program at FKIP Universitas Mataram is not yet equipped with practical work, and taking into account the students' need to deepen their knowledge of organic compounds, especially their synthesis and reaction mechanisms, the development of a chemistry magazine containing studies on aldol condensation synthesis is important as supporting reading material for students.

Research Methods

This study consists of two stages, namely laboratory research and magazine development. This study is a type of research and development (R&D), which is a method used to create and test new products. This study employs an R&D approach to develop products and assess their effectiveness. This study uses a descriptive method with a quantitative approach to provide an accurate picture of the data collected without aiming to generalize the results [17]. Descriptive research is a problem-solving method carried out by describing the current condition of the subject or object of research, in accordance with the existing facts, without manipulating the situation [18]. Quantitative research is a method that uses a systematic scientific approach, in which data is collected in numerical form, analyzed using statistical techniques, and produces conclusions that can be proven empirically [19].

The final result of this research is a chemistry magazine containing content on the cross-aldol condensation reaction mechanism developed using the 4D development model. The research methodology follows the 4D development model proposed by Thiagarajan, which

includes Define, Design, Develop, and Disseminate. The 4D model is a development design model developed by Sivasailam Thiagarajan, Dorothy S. Semmel, and Melvyn I. Semmel in 1974. This model is designed to produce educational products, such as learning media, modules, or other teaching tools, in a systematic and measurable manner [20].

The first stage is laboratory research. The synthesis procedure is carried out by reacting 2 mL of 10 M NaOH solution, 2 mL of ethanol, 1.12 mL of acetaldehyde, and 2.33 mL of acetophenone. The initial stage involves preparing a NaOH solution by dissolving 2 grams of NaOH in 5 mL of distilled water, then stirring until the solution is homogeneous. Next, 2 mL of the solution was reacted with 2 mL of ethanol, and 1.12 mL of acetaldehyde was added. The mixture was then stirred for 10-15 minutes. After stirring, 2.33 ml of acetophenone was added to the mixture, which was then stirred again for at least 30 minutes. Next, 20 ml of distilled water was added and stirred until a precipitate formed. The mixture is then left to stand for 24 hours, allowing a precipitate to form. The precipitate is filtered, then purified through recrystallization using ethanol as the solvent and dried at room temperature. The dry recrystallized solid is then weighed to determine its mass. Here is a brief explanation of each stage in the process:

a. Define
   At this stage, an analysis of the syllabus and lecture materials is conducted in accordance with the CPL for the Polyfunctional Organic Compounds lecture.
b. Design
   At this stage, initial planning is carried out regarding the development of a chemistry magazine before it is developed. The steps taken at this stage are compiling the text for the chemistry magazine and designing its format and layout. The design of the chemistry magazine is made in the form of a storyboard.
c. Development
   This stage focuses on creating the design product and producing a chemistry magazine that serves as learning support material for students in the Polyfunctional Organic Compounds course. The development stage includes validation testing by experts (prototype I), product revision, product testing (prototype II), and the final product.
d. Dessiminate
   At this stage, the product will be disseminated in two ways. First, the chemistry magazine will be given to lecturers teaching Polyfunctional Organic Compounds courses and submitted to the Chemistry Education Study Program at Mataram University as a reference and additional teaching material. The second method of dissemination is in the form of journal publications with the aim of expanding its distribution reach.

This research was conducted from June 2025 until completion at the Faculty of Teacher Training and Education, Mataram University. The subjects in this study were students of the Chemistry Education Study Program at Mataram University. The object of this study was a chemistry magazine containing content on cross-aldol condensation reactions, intended as supplementary reading for students. The data collection method employed research instruments, including validation sheets and questionnaires, to measure practicality. Data analysis techniques were carried out using quantitative descriptive methods. Quantitative descriptive data were obtained through questionnaires given to experts as validators and to students as respondents. Analysis of the results from the validators was carried out using Aiken's V formula, which can be statistically expressed with the following formula:

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

Description:
V : Validator agreement index regarding item validity.
s : Score assigned by each validator minus the lowest score in the category used (s = r – lo, where r = validator's chosen category score and lo = lowest scoring score).
n : Number of validators.
c : Number of categories chosen by validators.
The V index value obtained from the calculation can be categorized based on the index in Table 1.

Table 1. Aiken's V Index Validity Criteria

Index Range	Category
$V \leq 0.4$	Invalid
$0.4 < V \leq 0.8$	Valid
$0.8 < V \leq 1$	Highly Valid

[21]

The reliability level to ensure that the assessment instruments used are consistent and reliable uses the following percentage of agreement calculation formula:

$$(PA) = 100\%\,(1 - \frac{(A-B)}{(A+B)})$$

Description:
PA : Percentage of agreement
A : Highest Score
B : Lowest Score
The reliability criteria for the Borich formula used are presented in Table 2.

Table 2. Borich Reliability Formula Criteria

Percentage Obtained	Reliability Criteria
85.01%- 100.00%	Very Good
70.01%- 85.00%	Good
50.01%- 70.00%	Fairly Good
01.00%- 50.00%	Not Good Enough

[22]

Meanwhile, data obtained from student response questionnaires were analyzed to measure the practicality of the chemistry magazine that had been developed. Practicality was assessed using a Likert scale with a score range of 1 to 4. A score of 1 indicated a high level of disagreement, and a score of 4 indicated a high level of agreement with the given statement. The practicality questionnaire analysis can be calculated using the following formula:

$$P = \frac{F}{N} \text{ x } 100\%$$

Description:
P : Practicality Score
F : Total Score Obtained
N : Maximum Total Score
The practicality criteria of magazines can be categorized based on their practical value.

Table 3. Range of Student Response Data Index Results

Value	Category
80% < P ≤ 100	Very Practical
60% < P ≤ 80	Practical
40% < P ≤ 60	Less Practical
20% < P ≤ 40	Not Practical
0% < P ≤ 20%	Very Impractical

[23]

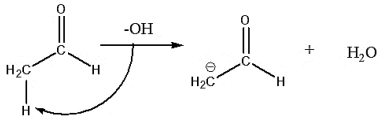
Result and Discussion

Cross-Aldol Condensation in the Laboratory

The cross-aldol condensation reaction between acetaldehyde and acetone compounds is carried out in the laboratory through two main stages, namely the synthesis process and the recrystallization process. The first stage involves reacting 2 mL of NaOH solution, 2 mL of ethanol, and 0.02 mol (1.2 mL) of acetaldehyde in a beaker, then stirring for 10-15 minutes. The main function of stirring using a stirrer (Magnetic Stirrer) is to homogenize the mixture and accelerate the reaction. The stirring system, utilising a magnetic stirrer, ensures that the solute and solvent have the same density (homogeneous) [24]. The second stage involves adding 0.02 mol (1.5 mL) of acetone and then stirring for an additional 30 minutes. The use of ethanol solution serves as a proton donor to the alkoxide ions formed, thereby producing hydroxide ions. This protonation process is essential for stabilizing the reactive species that appear in the early stages of the reaction. Furthermore, ethanol, as a protic solvent, helps maintain reaction equilibrium by providing an environment that allows for effective proton exchange [25]. In addition, the addition of NaOH solution serves as a catalytic base because it can deprotonate acetaldehyde to produce enolate ions (a nucleophile) that are reactive to acetone compounds [26].

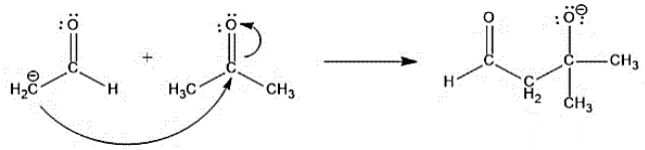
Next, in the second stage, recrystallization was carried out using 50 ml of hot ethanol. Recrystallization is a technique for purifying solids from impurities or mixtures by recrystallizing them after dissolving them in a solvent. Recrystallization is carried out to obtain purer crystals by dissolving the crystals, where the crystals and impurities can dissolve in a certain solvent when heated [27]. Next, the solution is poured into a chemical glass containing frozen distilled water, and 10% HCl is added dropwise. The addition of HCl aims to neutralize the alkaline solution resulting from the addition of NaOH solution [28]. The solution is then left for 2 x 24 hours until a precipitate forms. The precipitate is then separated from the solution and left at room temperature for the remaining solution to evaporate. Any remaining alcohol will evaporate at room temperature due to its relatively low boiling point and high volatility. This volatile nature allows the alcohol to quickly disappear from the mixture without the need for additional heating [29]. Next, the precipitate is weighed to determine its mass after recrystallization. The result obtained is a 0.0268 g orange-colored precipitate. Theoretically, the reaction mechanism that occurs is as follows**.**

Stage 1. Enolate Formation



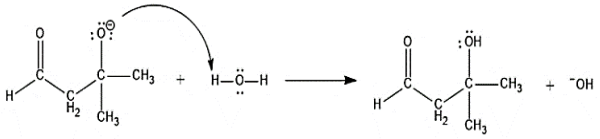
Hydroxide ions from NaOH deprotonate aldehydes to form enolate ions. The formation of the enolate ion by base is a step that takes longer than the subsequent steps. The amount of base used as a catalyst in this reaction is also important. Too much base can also oxidize acetaldehyde [30]. This deprotonation process also helps stabilize the reaction intermediate through resonance, thus facilitating the overall aldol condensation reaction.

Stage 2. Nucleophilic Attack



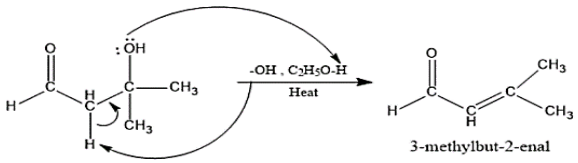
The enolate formed acts as a nucleophile, attacking the carbonyl carbon (C) of acetone to form a new C-C bond, resulting in an alkoxide intermediate. This alkoxide intermediate is unstable; therefore, in the next stage, it undergoes protonation to form an aldol product [31]. This C–C bond formation stage is the core of the aldol condensation reaction because it determines the basic structure of the resulting compound.

Stage 3. Protonation



The alkoxide (O^-) that is formed attacks the proton from H_2O and forms a β-hydroxy ketone (aldol). This protonation step is important because it converts a charged intermediate into an energetically more stable product. Furthermore, the formation of a β-hydroxy ketone marks the completion of the aldol addition reaction, which is the first step before dehydration can occur under certain conditions.

Stage 4. Dehydration



Aldol undergoes dehydration upon the addition of ethanol, where ethanol donates a proton, facilitating the release of water. At this stage, the OH^- ion acts as a base that withdraws the α proton (Hα), thus triggering the formation of a double bond between the α and β carbons. This elimination process yields an unsaturated carbonyl compound, specifically 3-methylbut-2-enal, which is recognised as an aldol condensation product. This dehydration step is crucial because it yields a more thermodynamically stable conjugated system, a key characteristic of the aldol condensation reaction [32].

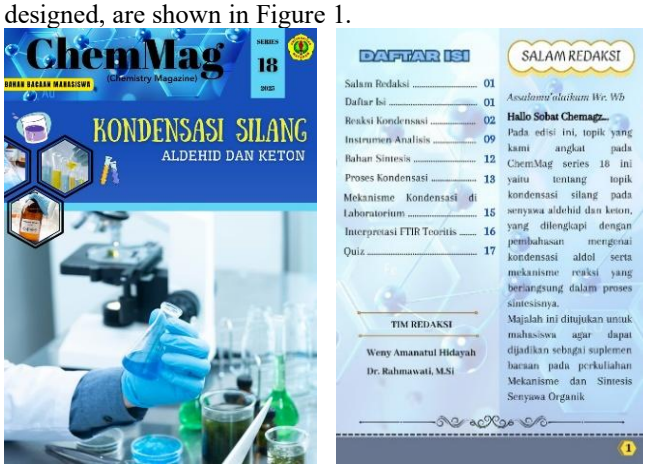
Chemistry Magazine Development

The development process of this magazine follows the 4D development model, which consists of four stages, namely define, design, develop, and disseminate, to ensure the feasibility and practicality of the final product.

In the Define stage, an in-depth analysis was conducted to identify the needs of students in the Chemistry Education Study Program, with a focus on the various problems that arise in chemistry learning, particularly in the polyfunctional organic compounds course. Based on the results of observations, most students had difficulty understanding chemistry concepts, especially in the aldol condensation material. The difficulties experienced by students occurred during the reaction mechanism stage of the chemical process. In addition, the polyfunctional organic compounds course lacks practical laboratory activities and is primarily taught theoretically through lectures, making the learning activities unengaging and dull, which further complicates students' understanding of the material. The questionnaire also included solutions proposed to address the problems faced. The researcher's solution is a reading supplement in the form of a chemistry magazine.

In the Design stage, the initial design of the magazine to be developed is carried out. The magazine design stage consists of two main stages: determining the magazine format and initial planning for the magazine. The designed chemistry magazine format consists of three main sections: the opening section, which contains the introduction; the main section, which contains the main material; and the closing section, which contains interesting games. The opening section of the magazine includes (a) the front cover, (b) the editorial greeting, (c) the table of contents, and (d) the editorial team. The content section includes (a) condensation reactions, (b) analytical instruments, (c) synthetic materials, (d) condensation processes, (e) condensation mechanisms, and (f) interpretation of theoretical FTIR spectra. The closing section includes (a) a quiz, and (b) the back cover.

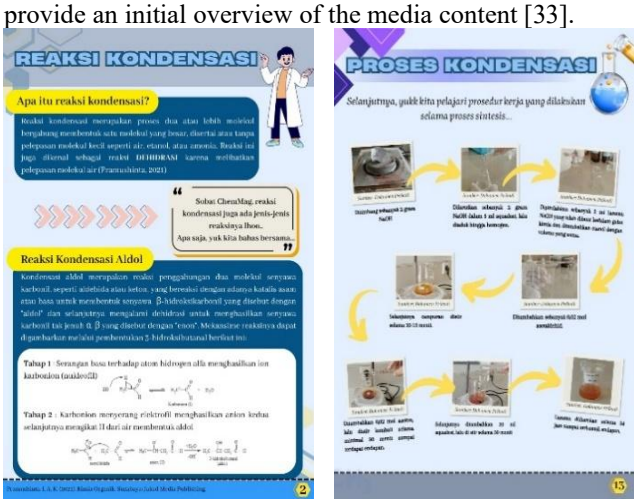
The second stage in the design process is the initial design, which is intended to design the chemistry magazine before it is tested. In the magazine design process, visual aspects are important to consider, such as color selection, font type, and the use of attractive images that are relevant to the content presented in order to increase interest in reading. The images displayed in the magazine are not only sourced from relevant sources but also from personal documentation, lending authenticity and making them a distinctive feature of this chemistry magazine. At this stage, the initial layout of the magazine is prepared based on the storyboard design created in accordance with the media to be developed. The front cover of the magazine and the opening page, as designed, are shown in Figure 1.



(a) (b)

Figure 1. (a) Chemistry Magazine Cover Design (b) Opening Page Section.

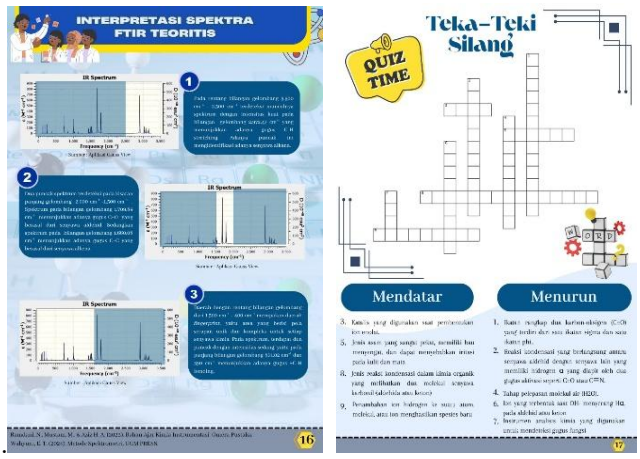
Figure 1 shows the design of the magazine cover and opening page. The magazine cover features the Mataram University logo, the magazine's serial number, title, and images related to the magazine's content. Meanwhile, the opening page contains a greeting from the editorial team, a table of contents listing the magazine's sections, and the names of the authors or editorial team who compiled the chemistry magazine. A well-designed print media structure must clearly display visual elements and main information on the cover, including the institution's identity, title, and relevant illustrations, to attract the reader's attention and provide an initial overview of the media content [33].



(a) (b)

Figure 2. Pages from a chemistry magazine (a) Material on condensation (b) The condensation process in the laboratory.

Figure 2 illustrates a portion of the magazine's content page. Figure (a) contains material on condensation, including the following page, which provides information on types of condensation, examples of reactions, and their applications in various industrial fields. Meanwhile, Figure (b) presents the steps for synthesizing organic compounds in the laboratory, so that users can understand how cross-aldol aldolcondensation is applied and improve their laboratory skills.



(a) (b)

Figure 3. (a) Interpretation of FTIR spectra (b) Interesting and educational quiz.

Figure 3 (a) shows the section of the magazine that also contains FTIR interpretations of the synthesized compounds to determine the chemical components contained

therein. Meanwhile, Figure (b) contains educational and interesting games. In the magazine, researchers designed crossword puzzles that can be used to evaluate understanding after readers have used the chemistry magazine. Overall, the sections of the chemistry magazine are listed in Table 4.

Table 4. Sections of the Chemistry Magazine

Section	Content	Page
Beggining Section	Front cover (title, serial number, university logo, magazine title, and chemical image)	Cover
	Introduction (editor's greeting, table of contents, and magazine editorial team)	1
Main Section	Types of condensation reactions and examples of their application.	2-8
	Introduction to FTIR as a chemical analysis instrument.	9-11
	Introduction to the materials used during the synthesis process.	12
	Condensation process in the laboratory.	13-14
	Condensation reaction mechanism.	15
	Theoretical FTIR spectrum interpretation	16
Closing Section	Crossword Puzzle Game	17

In the Develop stage, the designed chemistry magazine is realized in tangible form, then tested and refined based on the assessment results. The purpose of the development stage is to produce a chemistry magazine that meets the eligibility criteria after undergoing a validation process by validators, so that it can be used as reading material for students in polyfunctional organic compounds courses. To measure the validity and practicality of the chemistry magazine, two types of instruments were used: a validity sheet completed by validators and a questionnaire completed by students. The validation sheet is used to assess the extent to which the developed chemistry journal meets the validity criteria as additional reading material [34]. The validation sheet was used to assess the extent to which the developed chemistry magazine met the validity criteria as supplementary reading material. The validation sheet consists of four assessment aspects, namely graphics, presentation, content suitability, and language. Each aspect is assessed using the categories "strongly agree," "agree," "disagree," and "strongly disagree," with a section for suggestions and input to improve the developed magazine. The magazine validity test was conducted by three lecturers from the Chemistry Education Study Program. The validation process was carried out by submitting the magazine product and validation sheet to the validators. After the validation process was completed, improvements were made to the magazine according to the suggestions and input from the validators. The validation results for the four assessed aspects are presented in Table 5.

Table 5. Expert Validation Results for Chemistry Magazine

No.	Magazine Component	V	Category
1	Graphics	0.92	Highly Valid
2	Presentation Suitability	0.89	Highly Valid
3	Content Suitability	0.96	Highly Valid
4	Language Suitability	0.97	Highly Valid
Average		0.93	Highly Valid

Based on Table 5 above, the overall validation results have an average value of 0.93, indicating that the chemistry magazine developed is in the highly valid category, so it can be distributed as additional reading material for students with minor revisions based on suggestions and input from validators to improve the magazine developed.

Table 6. Reliability Analysis Results

No.	Magazine Component	R	Category
1	Graphics	0.95	Reliable
2	Presentation Suitability	0.90	Reliable
3	Content Suitability	0.96	Reliable
4	Language Suitability	0.97	Reliable
Average		0.94	Reliable

Table 6 above presents the results of the reliability test of the chemistry magazine using the percentage of agreement equation. The analysis results show that all aspects of the magazine have excellent reliability, with an average value of 0.94, or 94%, indicating that the chemistry magazine developed can be considered reliable and trustworthy.

Based on the results of the validity and reliability analysis presented, it can be seen that the chemistry magazine developed falls into the “highly valid” category, considering four aspects, namely graphic aspects, presentation aspects, content aspects, and linguistic aspects, which have been thoroughly evaluated to ensure that the magazine developed is of good quality. The validity results for the chemistry magazine, which features content on the cross-aldol condensation of aldehydes and ketones, are presented in Figures 4 and 5. These figures provide an overview of the validity level of each component that has been evaluated.

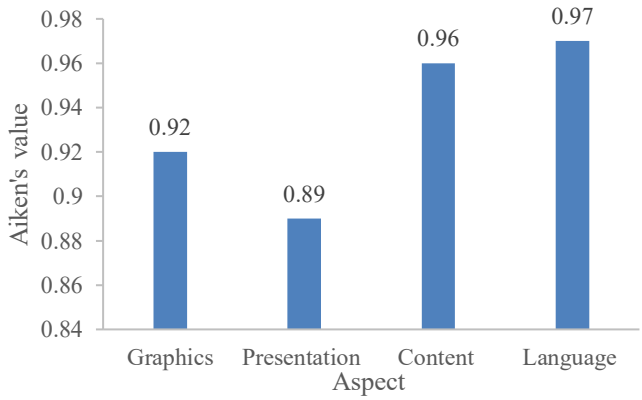


Figure 4. Expert Validation Results Chart.

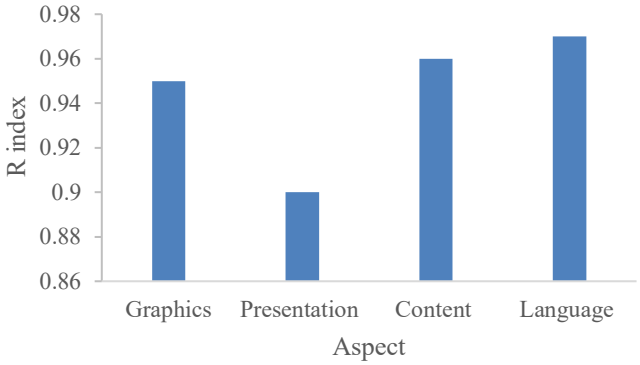


Figure 5. Graph of Reliability Results between Validators

Figures 4 and 5 show the validity scores for each aspect in the validation sheet. The highest value was in the linguistic aspect, with a value of 0.97, which is classified as highly valid with a validity percentage (PA) of 97%. This was followed by the content suitability aspect, with a value of 0.96, the graphic aspect, with a value of 0.92, and finally, the presentation aspect, with a value of 0.89. The graphic design component comprises three main aspects: magazine size, cover design, and magazine content design. In terms of size, the magazine adheres to the standard A4 size (210 x 297 mm), which is proportionate to the material presented. In terms of cover design, the magazine was assessed in terms of the selection of attractive colors that could clarify the visual function of the magazine. Meanwhile, the magazine's content design was evaluated based on several indicators, including the use of proportional margins, spacing between text and illustrations, and the placement of images that did not interfere with the titles or text in the magazine. The quality of the appearance of learning media, including size, layout and color selection, greatly influences the level of readability and effectiveness of material delivery [35].

The presentation aspect in chemistry magazines received an average validity score of 0.89, which is classified as highly valid with a validity percentage (PA) of 90%. These results indicate that the presentation techniques and supporting elements have been well designed and consistent. Magazines containing content on cross-aldol condensation reactions were declared highly valid based on several assessment indicators. First, each image presented is accompanied by a clear source or reference. Second, the material is organized systematically to help readers understand the magazine's content more easily. Meanwhile, the content feasibility aspect in chemistry magazines yielded an average validity score of 0.96, classified as highly valid with a validity percentage (PA) of 96%. These results suggest that the content presented in the magazine aligns with the material covered in the polyfunctional organic compounds course. Additionally, the magazine is recognised for its ability to enhance laboratory work skills, encourage readers to seek further information, and present material clearly and in an easy-to-understand manner. This aligns with the criteria for compiling effective magazine content, where the systematic presentation of material, supported by appropriate visual elements, can enhance understanding of the material presented [36].

The final assessment focused on the linguistic aspect, achieving an average validity score of 0.97, or 97%, which is classified as highly valid. Learning media that uses standard, communicative and ambiguity-free language is the main requirement for learning media to be understood effectively by readers [37]. The validity results were assessed based on several indicators, including the use of standard Indonesian in communicative sentences, avoidance of words or expressions that could lead to double interpretations or misunderstandings, and the exclusion of local/taboo language. Overall, the average V score for the four aspects was 0.93, indicating that the chemistry magazine is highly valid for use; however, it still requires revision to further improve the magazine. In addition, the percentage of agreement (PA) between the three validators regarding the chemistry magazine validation instrument obtained a score of 94%, which is classified as reliable. This score indicates a high level of agreement between the three validators in assessing the validity of the chemistry magazine.

Next, the chemistry magazine was tested on students of the Chemistry Study Program at Mataram University by distributing chemistry magazines and questionnaires to students who had completed the polyfunctional organic compounds course. A research instrument is deemed suitable for use if it has passed validity and reliability tests, which yield very good results, as these two tests ensure that the instrument is consistently capable of measuring what it should [38]. The questionnaire used had undergone validation and reliability testing by the validators, which yielded very valid and reliable results, with Cronbach's alpha scores of 0.94 and 0.93, respectively. The student response questionnaire consisted of 23 questions that covered various aspects, including attractiveness, content/material, language, and usefulness. Additionally, students provided suggestions and feedback regarding the chemistry magazine. The results of the student response questionnaire were then calculated using a percentage formula to obtain the practicality and effectiveness scores of the magazine. The results of the student responses are presented in Table 6.

Table 6. Results of the Practicality Analysis of Chemistry Magazines

No.	Aspect	Practicality	Categori
1	Magazine Appeal	85%	Very Practical
2	Magazine Content	85%	Very Practical
3	Language Use in Magazines	83%	Very Practical
4	Benefits of magazines	85%	Very Practical
Average		85%	Very Practical

Based on the analysis in Table 6, the average percentage value of the four aspects of the chemistry magazine assessment was 85%, indicating that the chemistry magazine falls into the “very practical” category. The practicality of this magazine is demonstrated through three aspects, each with a value of 85%. In terms of attractiveness, the magazine is designed to be as visually appealing as possible, featuring images relevant to the learning material to help students better understand the content. In terms of content, the chemistry magazine has been adapted to the cognitive level of students, making it easier and more effective for them to learn the material independently. This is in accordance with the requirements for compiling learning materials, which must still take into account the

cognitive development stage of students so that information can be processed more effectively and support independent learning [39]. Additionally, the magazine features engaging educational games, including interactive crossword puzzles.

The linguistic aspects of the chemistry magazine received a practicality score of 83%, placing it in the "practical" category. These results indicate that the language used in the magazine is communicative, featuring clear and easy-to-understand sentences that avoid double interpretations for readers. Based on the results of the practicality analysis by students, it can be concluded that the chemistry magazine developed is suitable as reading material for students. This conclusion is reinforced by the practicality analysis results, which show that the chemistry magazine falls into the "very practical" category. Thus, the chemistry magazine, which contains content on the cross-aldol condensation of aldehydes and ketones, can be used as additional reading material by students.

Conclusion

The chemistry magazine contains content on the cross-aldol condensation of aldehyde and ketone compounds, which was developed and obtained a validity score of 0.93, indicating that the magazine is suitable for use as reading material for students. The chemistry magazine developed has a practicality level with an average percentage value of 85%, which places it in the very practical category. Therefore, it can be concluded that the chemistry magazine can be used by students as supplementary reading material in lectures on polyfunctional organic compounds.

Author's Contribution

Rahmawati: conducted a literature review and prepared a draft article; W.A. Hidayah: developed the chemistry journal, research instruments, and performed data analysis; S.W. Al Idrus: reviewed the journal content, writing format, and provided research guidance.

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