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Need Analysis for Development (E-Module) of Analytical Chemistry Integrated with Environmental Analysis Research Results

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Abstract
The current condition is still limited to analytical chemistry teaching materials that are integrated with research results, only using Analytical Chemistry textbooks as teaching materials or in the form of e-books. This is one of the causes of the lack of student interest in participating in the teaching and learning process. The purpose of this research is to produce innovative teaching materials in analytical chemistry based on research results, aiming to enhance students' interest in learning.This research is the initial stage as a basis for developing analytical chemistry e-modules integrated with research results. The development model used is ADDIE which consists of five stages, namely Analysis, Design, Development, Implementation and Evaluation. This research is limited to the needs analysis stage which includes RPS analysis, analysis of problems and needs of lecturers and problems and needs of students. Data collection instruments used interviews and questionnaires. The subjects of this study consisted of 6 Analytical Chemistry lecturers and 59 students from Riau Province, Riau Islands, North Sumatra, and West Java. The research results of this preliminary analysis include RPS analysis where there are 10 topics of study material and based on the needs questionnaire the topic of quantitative analysis is the topic with the highest percentage to be developed into an e-module. Then also obtained the results that there are still some shortcomings with the teaching materials used today, so that 98% of lecturers and students stated that they need the development of teaching materials, especially those that are digital-based and can be integrated with research results which are evidence of the implementation of analytical chemistry learning theory.

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INTRODUCTION

The delivery of knowledge plays a crucial role in showcasing the attractiveness of each field. When the appeal of a particular field is high, optimal learning outcomes can be achieved due to the enthusiasm in following and understanding that field. Analytical chemistry is one of the relatively complex fields as it encompasses the fundamentals of qualitative and quantitative chemical analysis, which are related to other fields of chemistry such as organic, physical, inorganic, and biochemistry.

One way to enhance student enthusiasm is by developing innovative teaching materials in line with current trends, such as digital materials like e-modules. These materials can be easily accessed by students. This aligns with the opinion (Nita Sunarya Herawati, 2018) One rapidly evolving source of learning today is in the form of digital teaching materials, as we know that learning is not only conducted face-to-face but can also be done independently online. In line with the current curriculum demands, there is a need for independent learning utilizing

information and communication technology to enhance the efficiency and effectiveness of learning (Romayanti et al., 2020). One type of digital teaching material that can be used independently and systematically by students is an e-module. An e-module is a set of non-printed digital teaching media systematically organized and applied for independent learning purposes. Therefore, it demands learners to solve problems on their own. Another advantage of e-modules is that they are not limited to text and images but also include videos, animations, simulations, and other interactive elements (Asmiyunda, Guspatni, 2018). The use of electronic modules enables effective learning, as electronic modules can assist learners facing difficulties, facilitate structured and systematic learning, and present content in an organized format. In e-modules, there are materials and exercises that make it easier for learners to study the subject (Nita Sunarya Herawati, 2018).

Based on unstructured interviews with several lecturers of Analytical Chemistry courses from outside Universitas Islam Riau, it is found that there is a lack of instructional materials in Analytical Chemistry specifically based on research results. Currently, the teaching materials are limited to the use of Analytical Chemistry textbooks. Similarly, in the Chemistry Education Study Program at Universitas Islam Riau, textbooks and teaching materials used by lecturers do not integrate detailed research results. This condition is also consistent with the research (Junanto & Sartika, 2023) indicating that currently, lecturers still tend to be oriented towards textbooks and PowerPoint presentations.

There is one of the reasons for the lack of student interest in the teaching and learning process and a deeper understanding. Consequently, lecture materials are difficult to comprehend and easily forgotten by students. Therefore, it is hoped that a change in the method of knowledge delivery, through the renewal of teaching materials, can improve the achievement of learning objectives. Based on the interview results, the challenges faced by lecturers with the current teaching materials include the lack of contextual and factual examples in the teaching materials, as well as insufficient integration of technology in the materials. This has resulted in low student participation in the learning process, leading to a low understanding of concepts. Similarly, from the students' perspective, they express that the current teaching materials have limited examples of real-world learning implementations, lack innovation, and interactivity. Therefore, innovation is needed to align the materials with the current needs of students.

Based on the presented issues, the researcher will develop a prototype of digital teaching materials in the form of an e-module, with its novelty lying in integrating the research results from previous studies. Several studies conducted by the researcher related to environmental issues include (P. A. R. Yulis, 2019; P. A. rahma Yulis, 2018; P. A. R. Yulis & Sari, 2020; P. A. R. Yulis & Sari, 2022; P. A. R. Yulis et al., 2020; P. A. R. Yulis & Desti 2, 2020; P. A. R. Yulis, 2018; Putri Ade Rahma Yulis, Desti, 2018, and Ade et al., 2021), which can be integrated into the analytical course. The goal is for students to directly understand the application of the course, and this is also an effort to reduce environmental pollution. Providing up-to-date learning resources related to the environment can shape attitudes and concern for the environment and responsiveness to environmental problem-solving. The module designed based on research results creates more meaningful learning because the content presented in the module is more contextual and engaging. It is not only theoretical but also based on scientifically tested facts through research results (Sari et al., 2023) Furthermore, the development and implementation of a research-based curriculum can strengthen the learning process and enhance the understanding of learners (Fitriyati et al., 2015).

Before entering the development stages, preliminary analysis is necessary to determine the extent of the need for teaching materials, in line with the opinion of (Fauziah et al., 2021)that emphasizes the importance of conducting a preliminary research phase before the module

development process. This phase serves as the foundation for module development. Through preliminary analysis, it will be revealed whether the development of the module is necessary and if developed, whether it will have a positive impact on learning outcomes. This is also in line with what is stated by (Daniela et al., 2023) the process of identifying student characters and the resources needed is carried out by analyzing the teaching materials used previously as the main information in learning.

The initial stage of this preliminary analysis includes several activities, such as: analysis of the course syllabus (RPS), analysis of the teaching materials used, student problem questionnaires, and questionnaires on the needs of students and lecturers regarding the analytical chemistry course. This aligns with the findings of (Budiman et al., 2022) which emphasize that needs analysis is an initial foundation for developing curriculum content, teaching materials, and teaching methods that can enhance student motivation and success.

METHOD

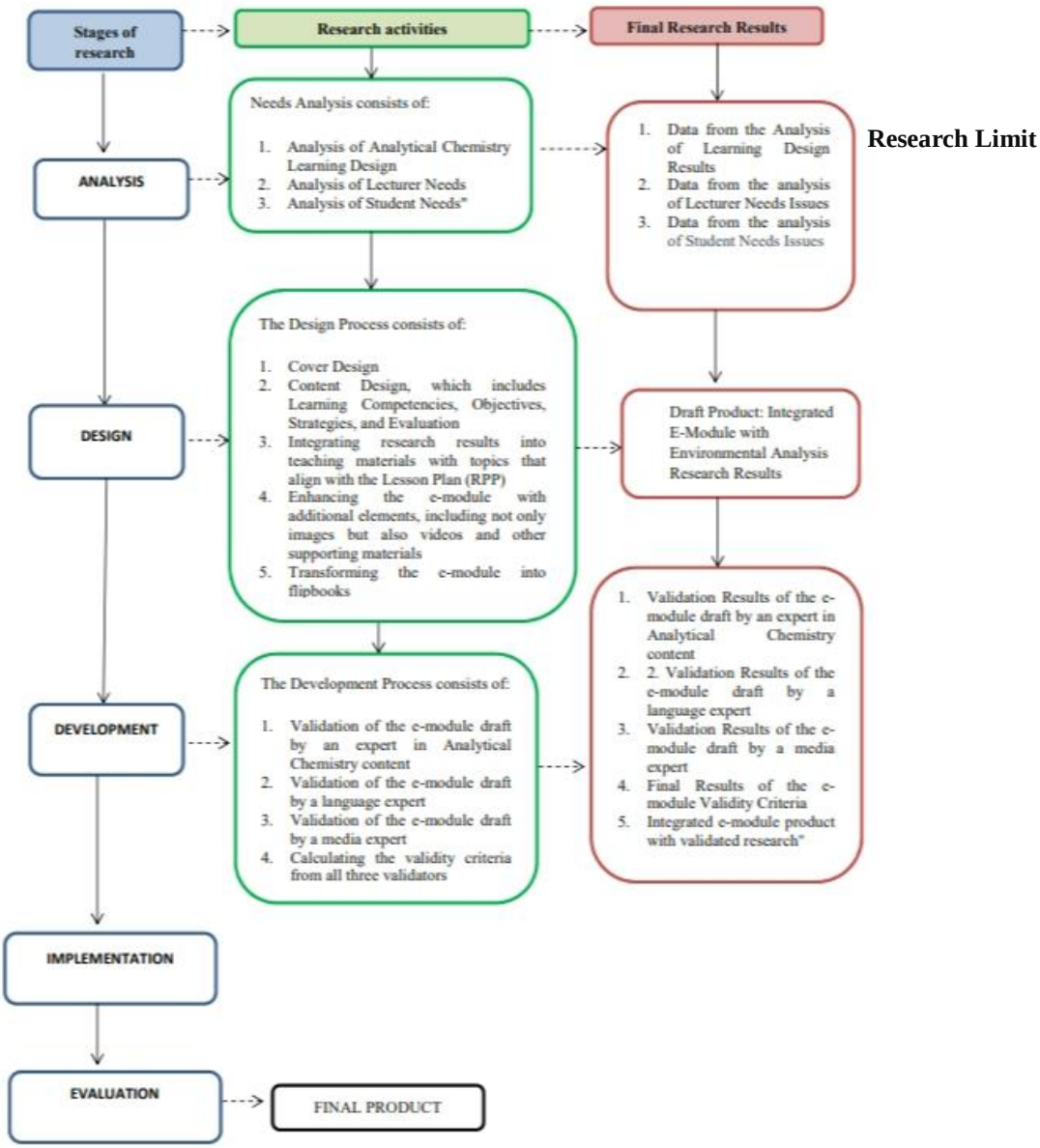


Figure 1. Research Flowchart

The method used in this research is the Research and Development (R&D) method utilizing the ADDIE model, which consists of five stages: Analysis, Design, Development, Implementation, and Evaluation. This study represents the first stage, which is Analysis, covering the analysis of student needs, analysis of lecturer needs, and analysis of the Course Syllabus (RPS – Semester Learning Plan). This research falls into the category of descriptive research conducted by describing, illustrating, and interpreting the results.

Research Subjects

The subjects in this study consist of 6 Analytical Chemistry lecturers, comprising 2 lecturers from the Riau Province, 1 lecturer from the Riau Islands Province, 1 lecturer from the North Sumatra Province, and 2 lecturers from the West Java Province. Additionally, 59 students who have taken the Analytical Chemistry course participated, with a breakdown of 55.93% from the Chemistry Education Study Program at the Faculty of Teacher Training and Education, Universitas Islam Riau (FKIP UIR), and 44.06% from outside the Chemistry Education Study Program at FKIP UIR. Both lecturers and students filled out questionnaires regarding the development needs of the module to be developed

Data Collection Techniques

Data was collected by the following technique:

1. Interviews and questionnaires for the analysis of lecturer needs
2. Interviews and questionnaires for the analysis of student needs
3. Observation sheets for the analysis of Analytical Chemistry learning design

Data Analysis Techniques

Descriptive analysis related to the needs of analytical chemistry lecturers, student needs, and analytical chemistry learning design. According to (Sastroadmojo, 2018), to analyze the obtained questionnaires, the researcher converts the data into percentage using the percentage formula.

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

Note: P = Percentage; F = Frequency of Answer Scores; and N = Number of Respondents.

The indicators for the preparation of the preliminary analysis research instrument include several aspects such as the availability of learning resources, the ability to use technology, and the need for alternative teaching materials.

RESULTS AND DISCUSSION

This research represents the initial stage of the development process of an integrated environmental research-based analytical chemistry e-module using the ADDIE model, which consists of five stages: Analysis, Design, Development, Implementation, and Evaluation (Liu & Jian, 2018). The analysis phase of ADDIE is initiated by an instructional issue that results in a careful look at the population of learners and their characteristics (Hess & Greer, 2016) .

This study is limited to the Analysis stage, which includes the analysis of the Analytical Chemistry 1 syllabus, analysis of problems and needs of analytical chemistry lecturers, and analysis of problems and needs of students. The aim of this stage is to analyze the necessity of developing teaching materials for learning objectives. This is in line with the statements by (Cahyadi, 2019) and (Fauziah et al., 2021) where the preliminary analysis aims to gather initial data as the foundation for module development.

Analysis of the Syllabus (RPS- Semester Learning Plan)

In the learning process, one crucial aspect is the semester learning plan containing topics to be covered throughout the semester. Based on the analysis of the syllabus used in Analytical Chemistry lectures, the following results were obtained:

Table 1. Lecture Topics in the Analytical Chemistry 1 Course

No	Study Material
1	The Position of Chemical Analysis
2	Preliminary Examination
3	Qualitative Analysis
4	Introduction to Quantitative Analysis
5	Gravimetric Analysis
6	Introduction to Titration Analysis
7	Acidimetric and Akalimetric Titrations
8	Precipitimetric Titration
9	Redox Titration
10	Complexometric titration-Chelatometry

Based on the analysis of the Semester Learning Plan (RPS), there are 10 topics in Analytical Chemistry 1. The purpose of this RPS analysis is to ensure that the resulting e-module aligns with the curriculum and student needs. This is in line with the statement by (Tia Yuliana, Milya, 2020) that RPS analysis is essential to determine the compatibility of lecture content and materials needed in module development. The alignment between the RPS used and the study material facilitates the achievement of learning objectives in the lecture process that students must attain. This is also consistent with the opinion of (Mustika et al., 2023) (Endah Marwanti et al., 2022) that RPS analysis is used to assess compatibility with study materials and facilitate the achievement of lecture objectives. From the survey on the needs for instructional material development, the highest results were obtained in the topic of quantitative analysis, with the details as follows: The analysis of the faculty's needs for the topic requiring the development of an e-module (67% for quantitative analysis material), followed by the analysis of students' needs (73% for quantitative analysis material). This is in accordance with the statement of Sungkono in (Lasmiyati ; Idris Harta, 2014) that the material in the module is selected and developed based on the competencies to be achieved and systematically designed to achieve learning objectives.

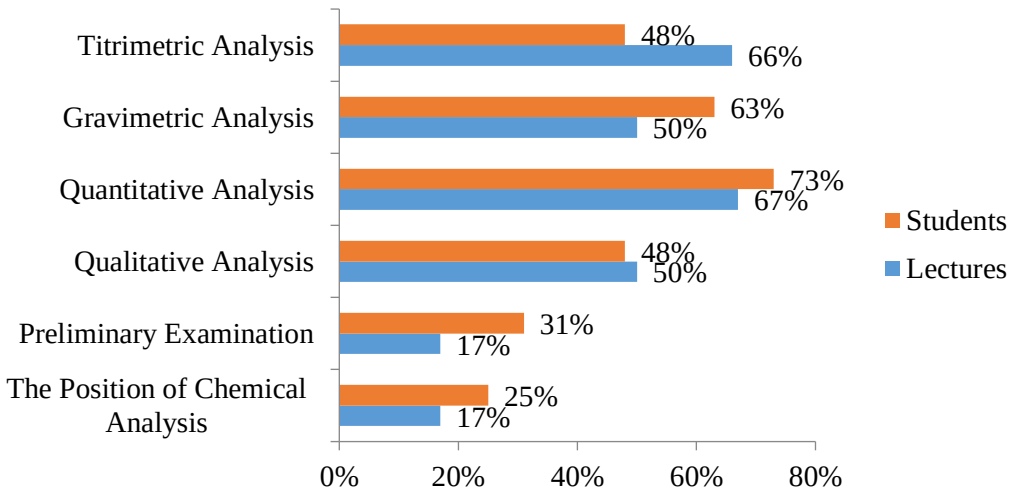
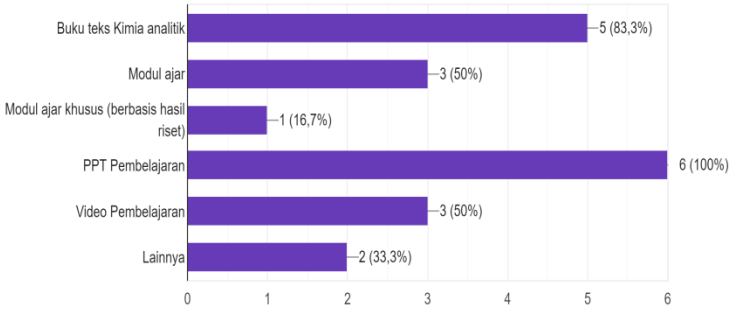
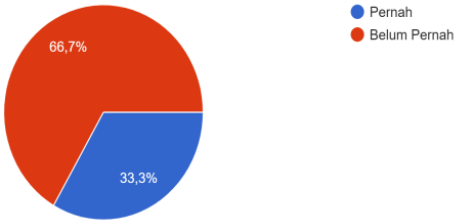
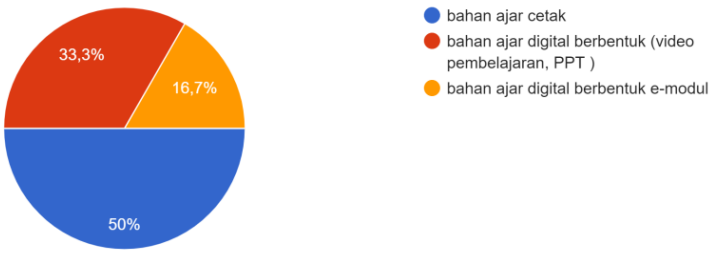


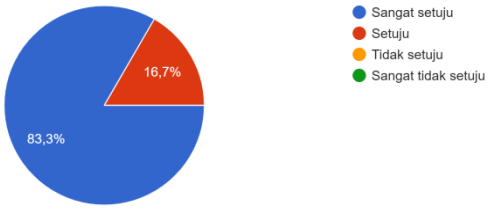
Figure 2. Percentage of material needs to be developed into e-modules

Analysis of Problems and Lecturers' Needs

The preliminary analysis is related to the issues and needs of analytical chemistry lecturers. In this stage, unstructured interviews and surveys were conducted with 6 lecturers teaching analytical chemistry from the provinces of Riau, Riau Islands, North Sumatra, and West Java. Based on the interview results, it was found that lecturers generally use Analytical Chemistry Textbooks as a reference for teaching, supplemented with some instructional materials but lacking detailed integration of research results. Subsequently, based on the survey, several analysis results were obtained as follows.

Table 2. Results of the Survey Analysis on Issues and Needs of Analytical Chemistry Lecturers.

No	Aspects analyzed	Analysis Result
1	Availability and types of learning resources used	All lecturers use teaching materials in the learning process. Based on the questionnaire, the percentage of the types of learning resources used is as follows: 
2	Disadvantages of teaching materials used so far	Based on the analysis, there are several disadvantages in the instructional materials used by lecturers so far, including not being relevant to students' daily lives, lacking examples of application, and requiring material selection as it is not entirely in line with the syllabus or the Semester Learning Plan (RPS). A total of 66.7% of lecturers have never produced research-based e-modules. 
3	The instructional material format that is frequently used	Among the commonly used instructional material formats, 50% use printed materials, 33.3% use digital materials such as PowerPoint presentations and instructional videos, and only 16.7% are using digital instructional materials in the form of e-modules. 

4	Difficulties or obstacles in learning analytical chemistry.	Based on the analysis results, some difficulties faced by lecturers include students' low understanding of concepts and analytical comprehension, leading to a lack of enthusiasm in learning and a dominance of the lecturer's role. Lecturers also face challenges in providing contextual and factual examples from the instructional materials used. Additionally, there is a lack of integration of technologies such as Artificial Intelligence (AI), Augmented Reality (AR), and Virtual Reality (VR) in the instructional materials.
5	The need for the development of alternative instructional materials in digital form and integrated with research results	Overall, analytical chemistry lecturers strongly agree and express the need for the development of analytical chemistry instructional materials in the form of e-modules that are integrated with research results to enhance student motivation and learning outcomes. Some suggestions for the development of the e-modules include: Engaging, varied, and easily understandable for students. Integration with current technological advancements. Presentation of material that includes real-life applications for students. Inclusion of research findings from journals. Incorporation of animations such as virtual laboratories 

Based on the survey results on the problems and needs of lecturers, it can be observed that lecturers have been using instructional materials, mainly textbooks and PowerPoint presentations. However, the learning process has not been engaging enough, leading to a lack of interest and motivation among students, resulting in many students not achieving the expected standards. The instructional materials used have not been tailored to differentiated learning according to the current needs and developments. The existing materials do not provide room for students to think creatively and analyze learning concepts in daily life, failing to meet the students' learning needs. Furthermore, many lecturers have not been producing their own modules but have been relying on existing sources. This has hindered the integration of technology to its maximum potential and adaptation to the characteristics of students.

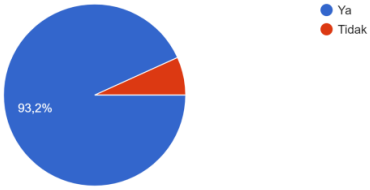
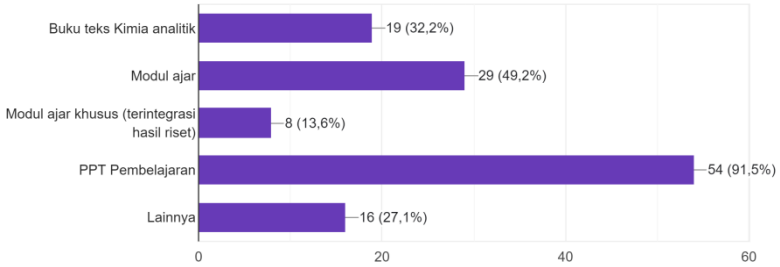
The learning process is still largely dominated by lecturers due to inadequate learning resources. To address these issues, there is a need for the development of integrated research-based analytical chemistry e-modules. This development aims to align with students' needs and enhance their understanding. This is consistent with the assertion by (Ardiansyah et al., 2016) that modules developed by educators can be adjusted to students' characteristics, such as social environment, culture, geography, pre-existing skills, interests, and backgrounds.

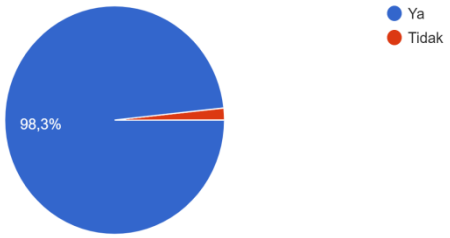
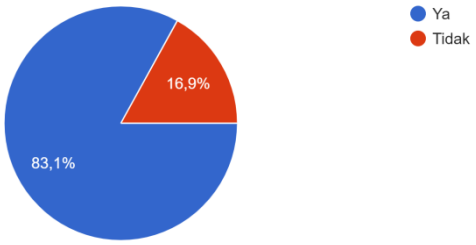
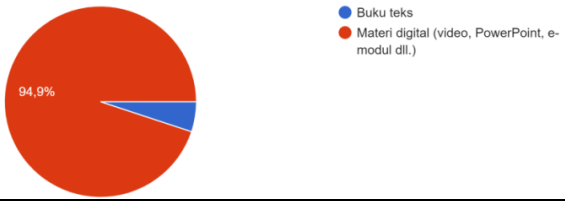
The development of instructional materials in the form of e-modules aims to provide students with the convenience of accessing learning materials anytime and anywhere, reducing dependence on textbooks and lectures' PowerPoint presentations. This approach is intended to enhance students' motivation to learn and foster a sense of responsibility for completing their studies. This aligns with the findings (Ardiansyah et al., 2016) who stated that modules focus on the ability to work independently and take more responsibility for their actions. Modules can provide control over learning outcomes by using competency standards that students must achieve in each module. Moreover, modules are relevant to the curriculum, demonstrated by their objectives and the ways to achieve them. This allows students to understand the connection between their learning and the outcomes they will attain.

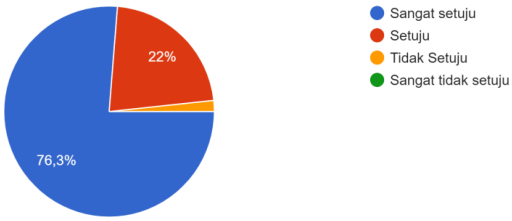
Analysis of Problems and Student Needs

An introductory analysis was also conducted on the problems and needs of students. In this stage, interviews and surveys on the needs analysis of 59 students from within and outside the Chemistry Education Study Program at FKIP UIR were carried out. These students came from the provinces of Riau, Riau Islands, North Sumatra, and West Java. Based on the interview results, it was found that, on average, students have been receiving instructional materials derived from lecturers' PowerPoint presentations, limiting access to information, especially those related to daily life or integrated with research results. Additionally, students prefer the use of digital instructional materials as they are considered more effective and efficient in the learning process. This is in accordance with what (Wijana, 2015) said that student needs analysis is important to be a point of view in teaching because it is through needs analysis that the lecturer, students, teaching materials, and teaching procedures can all be connected harmoniously to improve the learning process of students and to build the character and soft skills of students, as well as to support students in learning.

Table 3. Results of the Survey Analysis on Student Problems and Needs

No	Aspects analyzed	Analysis Result
1	The use of instructional materials by lecturers	The majority of lecturers use instructional materials in the analytical chemistry learning process, amounting to 93.2% 
2	The types of instructional materials used in learning	Lecturers have predominantly used instructional materials, particularly PowerPoint presentations, accounting for 91.5%. Some other types of instructional materials used are detailed as follows: 
3	Disadvantages of the instructional materials used so far.	Based on the analysis, there are several shortcomings in the instructional materials used according to students, including: Reading texts that do not encourage critical thinking among students. Lack of innovation leading to boredom in reading. Tendency to be used passively, sometimes containing terminology and terms that can cause cognitive burden for students. Insufficient practice questions and real-life applications. Unattractive design, making readers less interested in reading and learning. Infrequent availability of modules accompanied by practical videos. The use of instructional materials like textbooks makes it more difficult to understand, especially if they are in English. Lack of innovation in the instructional materials used. Monotonous instructional materials. Incompleteness, requiring students to seek additional references. Lack of use of interactive videos in instructional materials.

		Insufficient implementation in the surrounding environment. Lack of interactivity in the instructional materials used.
4	Additional learning resources.	In addition to the instructional materials used by lecturers, 98.3% of students seek additional sources from the internet. Some other additional learning resources used include e-books, instructional videos from YouTube, websites and blogs related to chemistry, as well as relevant journals and articles on analytical chemistry learning 
5	The implementation of analytical chemistry learning	Based on the analysis, 83.1% of students still experience difficulties in understanding the concepts of analytical chemistry during its implementation. Only 16.9% do not encounter challenges in the learning process of analytical chemistry 
6	Difficulties or obstacles in learning analytical chemistry	Some difficulties experienced by students in the process of learning analytical chemistry include: Difficulty in understanding concepts and formulas. Challenges in understanding analytical instruments, precision, accuracy, and limitations of laboratory equipment. Difficulty in understanding quantitative analysis material. Difficulty in comprehension due to instructional materials not fully presenting images related to the subject matter, leading to reliance on imagination. In analytical chemistry topics, there is a need to analyze precise results such as formulas and accurate calculations. Challenges in understanding reactions and calculations. The use of less common language and inadequate laboratory equipment make some material explanations difficult to understand. Difficulty in understanding material presented only in written form.
7	Preferred instructional material formats.	Based on the analysis of several students regarding instructional materials, 94.9% prefer instructional materials in digital form 
8	The need for the development of alternative instructional	Overall, 98% of students need and agree on the development of instructional materials in the form of e-modules that are integrated with research results to enhance motivation and learning outcomes for students

materials in digital form and integrated with research results	in the future. Some suggestions expected for the development of e-modules include: Modules containing explanations and concrete examples. Electronic instructional materials equipped with animations related to explanations about analytical chemistry. Online instructional materials with an attractive appearance and content packaged in an easily understandable, concise, dense, yet detailed manner. More engaging by providing example images that can help easily understand the studied material. More interactive instructional materials. Instructional materials that contain structured, interactive, and interesting content and examples. Displaying attractive visualizations to enhance students' understanding of the taught material, including visual examples and their relevance to everyday life. Integration with technology to make it easily accessible and interactive. Instructional materials that provide clear details of the content, numerous structured examples, and solutions, and the addition of supporting sources (if necessary). Having a non-monotonous appearance. Research-based and application-oriented instructional materials. Interactive instructional materials that can include explanatory videos. Modules equipped with images and instructional videos (in the form of links/barcodes) that can be directly linked to instructional videos. Teaching modules like e-modules for accessibility anywhere. Modules that can relate to and direct students to everyday life concepts, thus training life skills. Instructional materials that are creative and interactive enough to increase learning interest. Instructional materials such as articles that provide evidence or facts about learning. Colorful and meaningful displays with rich content, including numerous examples and discussions related to everyday life. 

Based on the survey results regarding the problems and needs of students, it can be observed that during the learning process, 93.2% of students stated that the lecturers had used instructional materials. However, the instructional materials used are still predominantly in the form of PowerPoint presentations, with the highest percentage compared to other learning materials, reaching 91.5%. The instructional materials used so far still have many shortcomings in terms of appearance and content, as they have not been integrated with research results or related to daily life. This makes it difficult for students to understand the concepts expected in the learning objectives. This is one of the reasons why students seek additional sources from the internet, such as e-books, journals, articles, chemistry websites, and blogs. However, these references have not been clearly validated for their accuracy, resulting in misconceptions about the concepts. Therefore, the development of modules that can be tailored to the needs and characteristics of students, originating from accurate and valid sources, is highly necessary.

From the analysis results, students express the desire for the development of instructional modules to be created in digital format, specifically in the form of electronic modules or e-modules. These e-modules should be equipped with videos related to the learning material and contextual concepts closely tied to everyday life. The intention is to enhance student motivation in the learning process, improve the quality of teaching, and elevate student learning outcomes. The preliminary analysis has provided numerous insights into the development of e-modules that align with the students' needs. This aligns with the opinion of (Fauziah et al., 2021), highlighting the crucial role of needs analysis in the teaching process to enhance the quality of education. Needs analysis not only aids in evaluation but also helps identify requirements for introducing changes that align with students' needs (Boroujeni et al., 2013). The needs analysis serves as a foundation for developing curriculum content, instructional materials, and teaching methods that can enhance student motivation and success (Budiman et al., 2022).

From the analysis of student needs, it was found that students require instructional materials in the form of modules containing evidence or facts about the learning they are engaged in. This can be achieved by integrating research or study results into instructional materials, thereby providing evidence of the application of learning concepts to daily life. This aligns with the opinion of (Parmin & Peniati, 2012) stating that published research results in journals are suitable references for module development because they are more applicable and meet contemporary criteria, making them effectively used in teaching. Based on the preliminary analysis, it can be observed that both lecturers and students require the development of e-modules in analytical chemistry to enhance the effectiveness of learning oriented towards the implementation of learning theories in daily life. This is consistent with the views of (Kusumawardhani et al., 2019) who argue that the use of e-modules can stimulate students' interest in learning because the delivery of material is not solely based on text but is also supported by components such as images, graphics, videos, animations, and supports self-directed learning for students due to the nature of e-modules that can be accessed anytime, anywhere, and repeatedly.

CONCLUSION

Based on the preliminary analysis conducted through interviews and the distribution of questionnaires to lecturers and students, it is evident that there are several issues related to instructional materials in analytical chemistry, and changes to these materials are necessary. The analysis indicates that both lecturers and students feel the need for the development of instructional materials. Therefore, this research can proceed to the next stage, namely the Design of e-module and its development. The planned instructional material will take the form of a digital e-module with the integration of research results, aiming to enhance student learning motivation by connecting it with real-life implementations.

RECOMMENDATIONS

This study is still in the initial stage, which is the preliminary analysis. Therefore, it needs to be continued to the next stages, including product development, validity and practicality testing, as well as effectiveness testing of the analytical chemistry e-module.

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