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Practicality of a Chemistry Module based on Basic Concepts and Practical Applications for First-Year Biology Education Students

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Abstract: Practicality of a Chemistry Module based on Basic Concepts and Practical Applications for First-Year Biology Education Students, Chemistry learning for biology education students is often challenging due to the abstract nature of concepts and the lack of teaching materials that integrate biological contexts. Therefore, practical and student-oriented modules are needed. This study aims to analyze the practicality of the module *"Chemistry for Beginners: Basic Concepts and Practical Applications"* developed for first-year Biology Education students at FKIP, University of Lampung. This study employed a quantitative descriptive method involving 80 students from the 2024 cohort. Data were collected using a practicality questionnaire consisting of nine Likert-scale indicators (1–4) and one open-ended item. Data were analyzed using descriptive percentage statistics and thematic analysis. The results showed that the module achieved an average practicality score of 86.4%, categorized as very practical, meaning it is easy to use, understandable, efficient, and beneficial for learning. The highest scores were found in font readability (92.5%) and the suitability of material sequence (91.3%). Students suggested adding more varied practice questions (45 responses), clarifying formula and symbol notations (28 responses), and correcting typographical errors (12 responses). In conclusion, the module is highly practical and feasible as a supporting teaching material. Improvements should focus on enriching practice questions, providing a glossary, and enhancing proofreading quality.

Keywords: module practicality, Chemistry Science, biology education, teaching materials, contextual.

Abstrak: Praktikalitas Modul Ajar Kimia Berbasis Konsep Dasar dan Aplikasi Praktis Bagi Mahasiswa Pendidikan Biologi, Pembelajaran kimia bagi mahasiswa pendidikan biologi sering menghadapi kesulitan karena sifat konsep yang abstrak serta keterbatasan bahan ajar yang terintegrasi dengan konteks biologi. Oleh karena itu, diperlukan modul yang praktis dan sesuai dengan karakteristik mahasiswa. Penelitian ini bertujuan untuk menganalisis tingkat praktikalitas modul *"Kimia untuk Pemula: Konsep Dasar dan Aplikasi Praktis"* yang dikembangkan untuk mahasiswa tingkat pertama Program Studi Pendidikan Biologi FKIP Universitas Lampung. Penelitian ini menggunakan pendekatan deskriptif kuantitatif dengan subjek 80 mahasiswa angkatan 2024. Instrumen yang digunakan berupa angket praktikalitas yang terdiri dari sembilan indikator skala Likert (1–4) dan satu butir saran terbuka. Data dianalisis menggunakan statistik deskriptif persentase dan analisis tematik. Hasil penelitian menunjukkan bahwa modul memperoleh skor rata-rata 86,4% dengan kategori sangat praktis, yang berarti mudah digunakan, mudah dipahami, efisien, dan bermanfaat dalam pembelajaran. Indikator tertinggi adalah keterbacaan font (92,5%) dan kesesuaian urutan materi (91,3%). Saran utama mahasiswa meliputi penambahan variasi soal (45 responden), penjelasan notasi rumus dan simbol (28 responden), serta perbaikan kesalahan penulisan (12 responden). Kesimpulannya, modul ini sangat praktis dan

layak digunakan sebagai bahan ajar pendukung. Perbaikan selanjutnya difokuskan pada pengayaan soal, penyusunan glosarium, dan peningkatan kualitas proofreading.

Kata kunci: *praktikalitas modul, IPA Kimia, pendidikan biologi, bahan ajar, kontekstual*.

▪ INTRODUCTION

Chemistry plays a fundamental role in higher education, particularly in preparing prospective biology teachers to understand scientific phenomena comprehensively. Mastery of basic chemistry concepts such as stoichiometry, acid–base theory, buffer systems, and salt hydrolysis is essential for explaining biological processes, including cellular metabolism and homeostasis (Feriani & Zainul, 2024). In the context of 21st-century education, chemistry learning is also expected to develop critical thinking and scientific literacy skills (Rahmawati et al., 2022). However, for biology education students, chemistry is often perceived as difficult due to its abstract nature, symbolic representations, and mathematical demands, which can hinder conceptual understanding and reduce learning motivation (Nurani & Suyanta, 2024).

One of the key factors contributing to this issue is the limited availability of teaching materials that integrate chemistry with biological contexts. Most existing materials present chemistry as a separate discipline, focusing on theoretical explanations and procedural problem-solving without linking concepts to real biological applications. As a result, students often fail to recognize the relevance of chemistry to their field of study. This condition indicates the need for contextual and interdisciplinary teaching materials that can bridge chemistry concepts with biological phenomena (Ro‘zmetova, 2025).

Previous studies have demonstrated that the development of chemistry modules using approaches such as Problem-Based Learning (PBL), guided inquiry, and STEM integration can improve learning outcomes and student engagement (Amryani et al., 2024; Asmi et al., 2024; Putri et al., 2024). These studies report high levels of validity, practicality, and effectiveness of the developed modules. However, most of these modules are designed for general chemistry learning or secondary education contexts, with limited attention to the specific characteristics and needs of biology education students. Moreover, prior research tends to emphasize validity and effectiveness testing, while the practicality aspect from the students’ perspective as end users is often reported descriptively without deeper analysis of user feedback and improvement priorities (Salsabila et al., 2025; Siregar et al., 2025).

In addition, although interdisciplinary learning has been widely promoted, only a few studies explicitly integrate chemical concepts with concrete biological applications in a structured and systematic manner. The lack of such integration creates a conceptual gap, where students may understand chemical formulas but struggle to apply them in biological contexts. Research shows that integrating chemistry into biology learning can significantly improve students’ understanding, motivation, and performance, especially when supported by contextual learning strategies (Meaders et al., 2025; Costabile et al., 2025). Therefore, there is a need for teaching materials that not only present chemistry concepts clearly but also connect them meaningfully to biological systems.

Based on these gaps, this study offers a novel contribution by developing and evaluating the practicality of a chemistry module specifically designed for biology education students using a contextual biological approach. The module *“Chemistry for Beginners: Basic Concepts and Practical Applications”* integrates fundamental chemistry topics with real biological applications, such as buffer systems in blood, acid–

base balance in physiological processes, and stoichiometric relationships in cellular respiration. Unlike previous studies, this research emphasizes in-depth practicality analysis, focusing not only on usability but also on identifying specific aspects for improvement based on systematic student feedback.

This study aims to analyze the practicality level of the developed module as perceived by first-year biology education students. Practicality in this study refers to the extent to which the module is easy to use, easy to understand, efficient in supporting learning, and beneficial for students (Amryani et al., 2024). The findings are expected to contribute to the development of more contextual, integrative, and user-oriented teaching materials, as well as to fill the research gap related to the evaluation of practicality in interdisciplinary chemistry modules.

▪ METHOD

This study employed a quantitative descriptive approach to analyze the practicality of a chemistry module based on students' perceptions. This approach was chosen because it allows for a systematic and measurable description of a product's usability without manipulating variables, making it suitable for evaluating teaching materials at the initial implementation stage (Sugiyono, 2019). The participants were 80 first-year students of the Biology Education Study Program, FKIP, University of Lampung, from the 2024 cohort, divided into two parallel classes. All participants had used the module for one semester (16 meetings) and met the inclusion criteria of at least 75% attendance and complete questionnaire responses.

Data were collected using a module practicality questionnaire developed based on indicators of teaching material usability, including ease of use, clarity of content, efficiency, and usefulness (Nieveen, 1999; Akker et al., 2006). The instrument consisted of 9 closed-ended items measured using a 4-point Likert scale (4 = strongly agree, 3 = agree, 2 = disagree, 1 = strongly disagree) and one open-ended item for suggestions. The measured indicators included material sequence suitability, ease of understanding, clarity of concepts, summary effectiveness, learning motivation, effectiveness of exercises, encouragement for exploration, layout design, and font readability.

The validity of the instrument was assessed by two experts (chemistry and biology education experts) using Aiken's V, resulting in an average value of 0.89, indicating high validity. Reliability testing using Cronbach's Alpha produced a coefficient of 0.91, which falls into the excellent category, indicating strong internal consistency (Hair et al., 2019). Data collection was conducted at the end of the semester through an online questionnaire, with a 100% response rate.

Quantitative data were analyzed using descriptive statistics (mean and percentage), then interpreted using practicality criteria adapted from Nieveen (1999) and Akker et al. (2006), where a score of 81–100% is categorized as very practical. Qualitative data from open-ended responses were analyzed using thematic analysis (Braun & Clarke, 2006) to identify patterns of student feedback. This study focuses on practicality as part of the formative evaluation stage, which aims to ensure that the module is easy to use, understandable, efficient, and useful before proceeding to effectiveness testing in further research.

▪ RESULT AND DISCUSSION

The Chemistry module entitled "Chemistry for Beginners: Basic Concepts and Practical Applications" was developed specifically to support first-year biology education students in understanding fundamental chemistry concepts that are essential for their future studies in biological sciences. The module covers four main topics: stoichiometry, acid-base chemistry, buffer solutions, and salt hydrolysis. Each topic is presented systematically with learning objectives, concept explanations, worked examples, practice questions, and chapter summaries. A distinctive feature of this module is its contextual approach, which explicitly links chemical principles to biological phenomena such as pH regulation in blood, the role of buffer systems in the human body, and salt hydrolysis in digestive processes. As part of the module development, the cover design plays an important role in attracting students' interest.

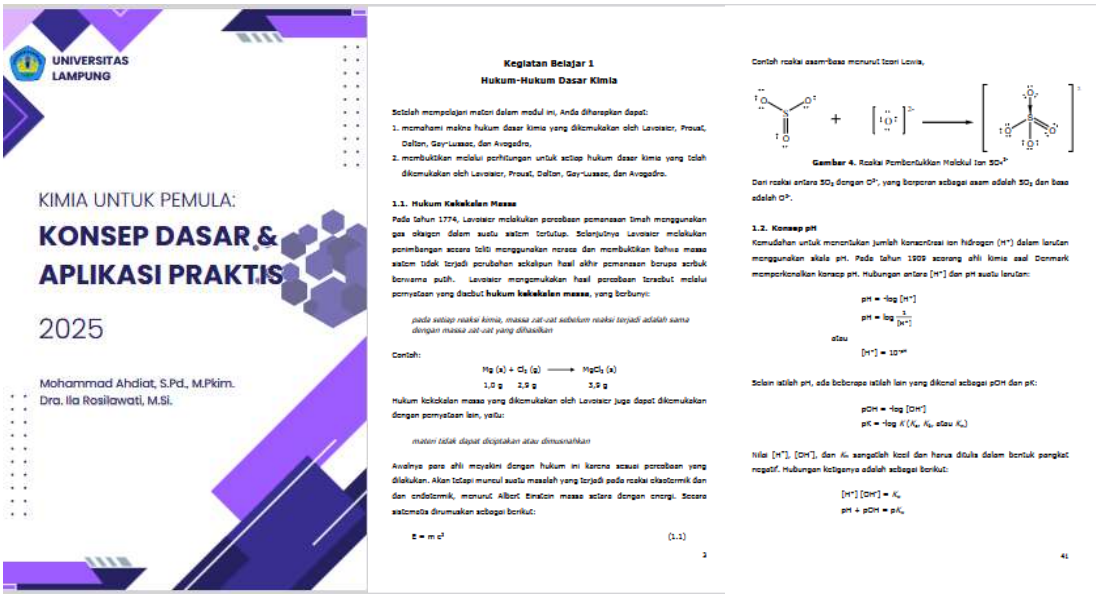

Figure 1. Chemistry module Based on Basic Concepts and Practical Applications

The Chemistry module "Chemistry for Beginners: Basic Concepts and Practical Applications" achieved a very practical level with an average score of 86.4% (SD = 3.8) based on assessments from 80 first-year biology education students (Table 2). All nine indicators scored above 79%, with eight indicators in the "very practical" category (≥80%) and one indicator approaching the threshold. This result aligns with previous studies on PBL-based modules (Amryani et al., 2024: 86% from students) and teaching factory-based e-modules (Okterina et al., 2025: 93% from students).

Table 2. Distribution of Student Responses on 9 Closed Indicators (N=80)

Indicator	Very (4) f (%)	Sufficient (3) f (%)	Less (2) f (%)	Not (1) f (%)	Mean (SD)	Percentage
1. Sequence suitability	58 (72.5)	20 (25.0)	2 (2.5)	0	3.70 (0.52)	92.5%
2. Ease of understanding	37 (46.25)	36 (45.0)	7 (8.75)	0	3.38 (0.64)	84.5%

3. Clarity of concepts	42 (52.5)	35 (43.75)	3 (3.75)	0	3.49 (0.57)	87.3%
4. Summary effectiveness	55 (68.75)	22 (27.5)	3 (3.75)	0	3.65 (0.56)	91.3%
5. Participation motivation	45 (56.25)	28 (35.0)	6 (7.5)	1 (1.25)	3.46 (0.71)	86.5%
6. Exercise effectiveness	35 (43.75)	32 (40.0)	10 (12.5)	3 (3.75)	3.25 (0.81)	81.3%
7. Exploration encouragement	32 (40.0)	33 (41.25)	13 (16.25)	2 (2.5)	3.19 (0.78)	79.8%
8. Layout design	34 (42.5)	39 (48.75)	7 (8.75)	0	3.34 (0.63)	83.5%
9. Font readability	55 (68.75)	23 (28.75)	2 (2.5)	0	3.66 (0.53)	91.5%
Average	-	-	-	-	3.46 (0.32)	86.4%

Figure 1 shows a clear bimodal pattern: four indicators clustered above 87% (font readability 92.5%, sequence suitability 91.3%, summary effectiveness 91.3%, concept clarity 89.4%), while three indicators fell below 84% (exploration encouragement 79.8%, exercise effectiveness 81.3%, layout design 83.5%). This pattern suggests that the module excels in passive readability features but underperforms in active learning support features. The highest-rated indicator, font readability (92.5%), confirms that the typography (Arial 11-12 pt) meets readability standards for both printed and digital teaching materials (Siregar et al., 2024). The indicator for material sequence suitability (91.3%) reflects successful application of the scaffolding principle, reducing cognitive load by progressing from basic concepts to complex applications (Kurnia et al., 2025).

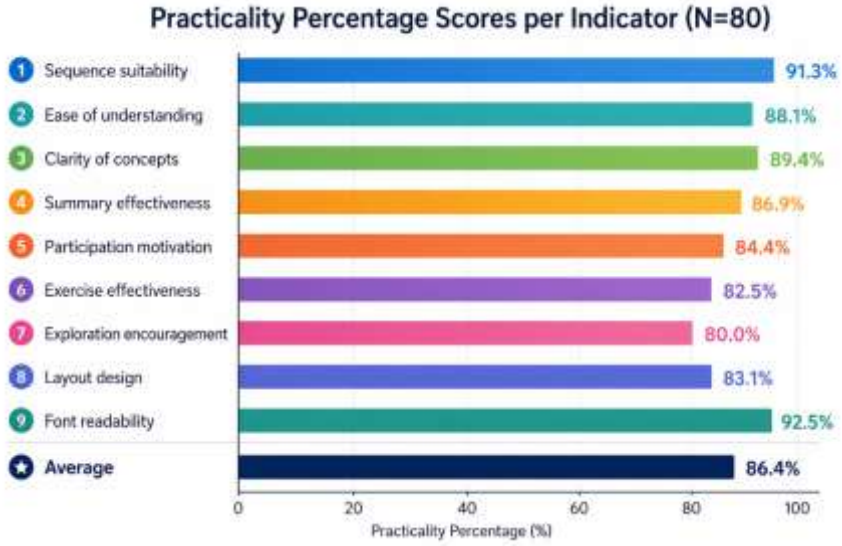

Figure 1. Graph of Practicality Percentage Scores per Indicator (N=80)

The lower indicators provide clear direction for revision. Exploration encouragement (79.8%) was the only indicator below the practical threshold, indicating

that the module lacks cross-references to additional learning resources. This finding aligns with Costabile et al. (2025), who demonstrated that interactive simulations effectively integrate didactic and active approaches. Exercise effectiveness (81.3%) corresponds directly to open-ended suggestions from 45 respondents (56.25%) requesting more varied sample questions. Biology students require more worked examples than chemistry majors because they lack automaticity with chemical notation (Khaira & Ibrahim, 2024). Layout design (83.5%) received moderate scores; students suggested adding more colorful visual elements and boxing important formulas, consistent with multimedia learning principles (Mayer, 2021).

Analysis of open-ended suggestions from 80 students identified two additional priority themes: explanation of formula and symbol notations (28 respondents, 35.0%)—particularly for Ka, Kb, pKa, and α—and correction of typographical errors (12 respondents, 15.0%). The request for formula notation explanations highlights a symbolic literacy barrier. Symbols routine for chemistry students represent unfamiliar cognitive load for biology students, supporting Ro'zmetova's (2025) finding that interdisciplinary integration enhances knowledge quality. Typographical errors, though reported by a minority, affect credibility and should be addressed through rigorous proofreading (Kurnia et al., 2025).

This study measured perceived practicality, not cognitive improvement. Future research should employ pretest-posttest designs to measure learning effectiveness (Ardi et al., 2025) and develop interactive e-module versions with embedded simulations to address the exploration encouragement gap (Tonapa & Atun, 2024).

▪ DISCUSSION

The average practicality level of the module falls into the very practical category, aligning with previous findings on PBL-based modules (Amryani et al., 2024). This confirms that modules with systematic structure, clear language, and contextual relevance achieve high practicality. The high rating for material sequence suitability reflects the application of the scaffolding principle, which presents material from basic concepts to more complex ones, thereby reducing cognitive load. This finding is consistent with studies reporting very positive student responses to well-structured e-modules (Kurnia et al., 2025; Rasyih et al., 2024). Such a principle is reinforced by guided inquiry-based modules that demonstrate strong feasibility for classroom implementation, supporting students' progression toward relational-level conceptual understanding (Siregar et al., 2025).

The ease of understanding the material and clarity of concepts indicate the module's success in translating abstract chemistry concepts into language and visualizations that are more accessible for biology students. This achievement is in line with research on Guided Discovery Learning-based e-modules, which obtained high validity percentages from media experts (Salsabila et al., 2025). The explanation of acid-base theories accompanied by molecular structure images and coordinate bond formation was well visualized in the module. As noted by Mulia (2025), a guided inquiry-based module demonstrates a very high level of practicality, supporting students in constructing conceptual understanding independently through a process-oriented approach. The use of multiple representations in electronic teaching materials aids students in translating across macroscopic, submicroscopic, and symbolic levels (Nurani & Suyanta, 2024).

The effectiveness of the module's summaries supports cognitive theory regarding the importance of retrieval practice in long-term memory consolidation. Summaries

arranged in numbered points help students identify the essence of the material by utilizing the principle of signaling in instructional design, which directs attention to the most relevant information (Kurnia et al., 2025). The effectiveness of systematic summaries has also been demonstrated in creating valid and practical chemistry teaching materials. Furthermore, combining a guided inquiry model with a flipped learning approach significantly impacts students' science process skills and chemical literacy (Tonapa & Atun, 2024).

Motivation for active participation in lectures indicates that the module functions as an effective advance organizer in learning. This finding is consistent with studies where user responses to e-modules were highly positive from both teachers and students (Rasyih et al., 2024; Siregar et al., 2025). Enhanced confidence encourages students to ask questions and actively discuss in class. The effectiveness of e-modules in improving student learning outcomes has also been proven, showing significant improvement with high N-Gain scores (Ardi et al., 2025). A module developed with an integrated STEM approach allows students to engage in interdisciplinary learning, significantly increasing their confidence across multiple sciences (IEEE, 2025).

Two indicators received relatively lower scores: the effectiveness of practice questions and encouragement for exploration. The lower effectiveness of practice questions is attributed to the limited number of questions and lack of variation in difficulty levels. This aligns with research where experts reached consensus on the need for additional module components to improve problem-solving skills (Khaira & Ibrahim, 2024). The lower score for exploration encouragement indicates that the module has not been optimal in providing cross-references or links to additional learning resources, a gap emphasized by Meaders et al. (2025), who highlighted the importance of addressing chemistry concepts early with sufficient student support. Layout and font readability have met typographic standards, though several students suggested adding more colorful visual elements and boxing important formulas. Following multimedia learning principles (Mayer, 2021), strategic use of color aids visual differentiation between related abstract concepts. The use of interactive simulations has proven effective in integrating didactic and active approaches (Costabile et al., 2025).

Analysis of open-ended suggestions revealed three main themes for revision: addition of more varied sample questions, explanation of symbol notations, and correction of typographical errors. The need for sample questions aligns with cognitive learning theory about the importance of exemplification in building mental schemas. Students need demonstrations of applying formulas in various contexts, and e-modules with sufficient sample questions significantly affect critical thinking skills (Putri et al., 2024). The request for formula notation explanations reflects challenges faced by biology students unfamiliar with chemical terminology, and integrating chemistry with other disciplines enhances knowledge quality and motivation (Ro'zmetova, 2025). The STEM approach also proves effective in transforming isolated knowledge into integrated systems (Bak et al., 2025). Although typographical errors were reported by a minority, their impact on credibility is significant, requiring careful revision as emphasized in the ADDIE model (Siregar et al., 2024; Kurnia et al., 2025). A limitation of this study is that practicality was measured only through subjective perceptions; future research should employ experimental designs and develop interactive digital formats with animations and simulations (Okterina et al., 2025; Weitzel et al., 2025).

▪ CONCLUSION

Based on the results of the analysis and discussion, it can be concluded that the Chemistry module "Chemistry for Beginners: Basic Concepts and Practical Applications" developed for students of the Biology Education Study Program, FKIP, University of Lampung, has a very high level of practicality. Based on assessments from 80 student users, the module obtained an average percentage score of 86.4%, falling into the very practical category. The indicators with the highest achievements were font readability (92.5%) and the suitability of the material sequence with the lecture contract (91.3%), indicating that the typography and structure aspects of the module have been designed very well and are suitable for student needs. Meanwhile, the indicators requiring further improvement in the next revision are the encouragement for additional information exploration (79.8%) and the effectiveness of practice questions (81.3%).

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