

CONTEXTUAL BASIC CHEMISTRY MODULE DEVELOPMENT FOR BIOLOGY STUDENTS WITH DIVERSE ABILITIES: AN INCLUSIVE AND DIFFERENTIATED LEARNING APPROACH

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Abstract

This study explores the design and development of a contextual basic chemistry module specifically tailored to meet the diverse academic needs of undergraduate biology students. Recognizing the varying educational backgrounds and learning styles of students, the module was systematically created using the ADDIE instructional model, incorporating principles of inclusive pedagogy and differentiated instruction. To enhance accessibility and relevance, the module's content was closely linked to biological concepts and enriched with diverse features such as visual aids, interactive elements, and tasks structured at multiple levels of difficulty. The module was evaluated through a limited-scale implementation involving 25 students from the Tadris Biology program at Muhammadiyah University Aceh, who participated as respondents. Results from this implementation indicated notable improvements in students' engagement, conceptual understanding of chemistry, learning motivation, and autonomy. These findings underscore the effectiveness of contextual and inclusive teaching strategies in fostering equitable learning environments and addressing conceptual gaps in interdisciplinary education, particularly for biology students navigating foundational chemistry topics.

Keywords: Contextual learning; inclusive education, module development; general chemistry; differentiated learning

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INTRODUCTION

Basic chemistry is a fundamental course in the biology curriculum, as many biological processes such as metabolism, enzyme activity, respiration, and protein synthesis are rooted in chemical principles [1]. However, biology students often find chemistry challenging, perceiving it as too abstract and disconnected from their field of study [2]. It means Biology students frequently struggle with chemistry because they see it as abstract, formulaic, and unrelated to biological processes. Unlike biology, which focuses on observable living processes, chemistry investigates molecular structures, reactions, and equations that may appear divorced from real-world applications. This perceived distance across disciplines might impede student involvement and comprehension. When chemical principles are presented without a clear relationship to biological occurrences, students may struggle to understand their importance or practical application. As a result, many biology students see chemistry as a barrier rather than a helpful foundation for comprehending the molecular basis of life.

Moreover, students entering the course come from diverse academic backgrounds. Some have strong foundations in chemistry from high school, while others struggle with basic concepts. Others may have had little or fragmented chemistry instruction. This irregularity results in variable levels of past knowledge, which influences how fast and successfully pupils interact with new content. Those with inferior backgrounds may fail to follow courses, apply concepts, or comprehend abstract principles, resulting in decreased confidence and academic success. Students with better foundations, on the other hand, may make faster progress, resulting in a notable gap in classroom learning dynamics. This mismatch not only makes it difficult for instructors to create inclusive lesson plans, but it also has an impact on collaborative learning activities, which require peer understanding. Addressing these learning gaps necessitates individualized instruction and support strategies based on each student's academic starting place. This disparity contributes to learning gaps. To address this issue, the implementation inclusive and differentiated teaching strategies are essential [3], [4].

This study aims to develop a contextual basic chemistry module based on biological content and inclusive pedagogical principles to support students with varying learning abilities and needs [5].

Recent trends in science education emphasize personalized learning experiences to enhance student engagement. The shift towards inclusive pedagogy underscores the importance of integrating contextually relevant content to foster better understanding among learners [6]. This pedagogical progression is based on the awareness that students bring a variety of backgrounds, prior knowledge, and learning preferences to the classroom. Educators can reduce comprehension gaps and make scientific concepts more accessible by customizing education and using examples relevant to students' daily life or academic disciplines. Contextual learning, when combined with inclusive tactics like customized instruction and the use of assistive technologies, not only enhances cognitive outcomes but also increases motivation and emotional attachment to the subject. As a result, students are more likely to participate actively, retain knowledge for longer, and apply what they've learned to real-world situations. This comprehensive approach to teaching ensures that no student falls behind in their pursuit of scientific literacy. Biology students, for instance, are more likely to grasp complex chemical concepts when those concepts are presented in relation to biological systems [7].

Differentiated instruction (DI) frameworks have proven effective in addressing learner variability. By delivering content in multiple formats and allowing different response modes, DI enhances student access and engagement [8]. Integrating DI into science instruction ensures that students with learning difficulties can access and process information meaningfully.

Another relevant approach is Universal Design for Learning (UDL), which aims to provide equal opportunities by accommodating learning preferences through flexible content delivery and assessment options. UDL has been shown to be particularly effective in STEM fields, including chemistry, which often presents high levels of abstraction [9].

Inclusive chemistry education also benefits from the implementation of real-world problems and digital learning resources. Studies reveal that interactive tools and multimedia representations not only enhance understanding but also promote motivation among low-performing students [10]. By introducing real-world examples, students may see how chemistry applies in everyday life, which helps to increase their engagement with the subject. Virtual labs, simulations, and educational games are examples of digital technologies that provide hands-on experiences tailored to different learning styles, allowing students to experiment and learn at their own speed. Furthermore, these tools provide quick feedback,

which is essential for reinforcing concepts and building student confidence. As a result, students, even those who struggle in traditional classroom settings, can have a more tailored and accessible learning experience. The availability of these materials assures that all students, regardless of academic background, have equal possibilities to excel in chemistry classes.

Given the growing demand for interdisciplinary competence, and accessible learning environments, designing a module that merges biological contexts with core chemistry concepts while accommodating diverse abilities is essential. This method not only promotes a greater grasp of both subjects, but it also emphasizes their interconnections, which is important for students pursuing jobs in fields such as environmental science, biochemistry, or medicine. By combining biology and chemistry, the program allows students to see the actual applications of theoretical concepts, making the learning experience more relevant and engaging. Furthermore, it ensures that students with varied levels of prior knowledge and learning styles can effectively engage with the topic. This study contributes the existing literature by presenting a validated, inclusive, and differentiated chemistry module tailored for biology students. It uses a variety of instructional methodologies, including collaborative learning, problem-based exercises, and multimedia resources, to serve a wide range of learning styles and abilities. The curriculum also features built-in scaffolding, which helps struggling students while challenging more experienced learners with new objectives. As a result, it fosters an inclusive learning environment in which all students can thrive and develop multidisciplinary skills.

METHOD

Research Design

This study employed the ADDIE (Analysis, Design, Development, Implementation, and Evaluation) model to guide the development of the contextual chemistry module. The ADDIE model is a well-established instructional design framework that allows for iterative and systematic development of instructional materials [11], [12]. The methodology consisted of five stages as described below.

Analysis

A needs analysis was conducted through a diagnostic assessment and student interviews to identify challenges in learning basic chemistry. Findings revealed a gap in conceptual understanding due to abstract content delivery and a lack of relevance to biology contexts [13].

Design

The module was designed by aligning learning outcomes with contextual materials relevant to biological systems. Differentiated instruction strategies, such as tiered tasks and multiple representations, were embedded to accommodate diverse learners [14].

Development

The module was developed using visual media, interactive simulations, and real-life case studies in biology. It included multiple formats (textual, visual, and audio) following UDL guidelines to support learners with varied needs [15].

Implementation

The module was piloted with 25 biology students in a basic chemistry course over three sessions. Students accessed materials through a hybrid learning management system (LMS) and participated in group discussions and individual reflections.

Evaluation

Formative evaluation was conducted using pre- and post-tests, reflective journals, and observation checklists. Quantitative and qualitative data were analyzed to assess improvements in students' understanding and engagement.

This model was chosen for its flexibility and suitability for developing educational tools that support for diverse learners in higher education science settings [17].

Research Participant

The participants included 25 undergraduate biology students from Universitas Muhammadiyah Aceh. These students exhibited varying levels of prior chemistry knowledge, as determined by diagnostic pre-tests.

Research Instruments

To evaluate the effectiveness of the teaching intervention, various tools were employed. A diagnostic test comprising multiple-choice and short-answer items assessed students' initial chemistry knowledge. A student perception questionnaire, utilizing a 1–5 Likert scale, gauged engagement, clarity, and relevance of the learning experience. An observation sheet allowed lecturers to document student participation and learning behaviors during the sessions. Lastly, a 20-item pre-test and post-test assessment measured the improvement in students' conceptual understanding before and after the intervention. These tools provided a comprehensive analysis of both learning outcomes and student perceptions. The detailed instruments employed in this study is depicted in Table 1.

Table 1. Research instruments utilized in the study

No	Research instrument	Purpose
1	<i>Diagnostic Test</i>	Assessing initial chemistry knowledge.
2	<i>Student Perception Questionnaire</i>	Utilized to evaluate engagement, clarity, and relevance.
3	<i>Observation Sheet</i>	Used by lecturers to record student participation and learning behavior.

4	<i>Pre-Test and Post-Test</i>	Utilized to measure conceptual understanding.
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Module Description

The module integrates key chemistry concepts with biological contexts to enhance relevance and understanding. It covers atomic structure, chemical bonding in macromolecules, thermodynamics in metabolism, acid-base equilibrium in cellular functions, and redox reactions in respiration and photosynthesis. Each topic features visual aids like infographics and simulations, tiered tasks to cater to different skill levels, reflective journaling for deeper engagement, and formative quizzes to reinforce learning and assess progress. Detailed structure is depicted in Table 2.

Table 2. The construction of the contextual module

Conceptual unit	Subunit contents
Atomic Structure and Biological Elements	<ul style="list-style-type: none"> Biological context introduction Visual aids (infographics, simulations) Three-level task differentiation (basic, intermediate, advanced) Reflective journal prompts Formative quiz
Chemical Bonding in Macromolecules	<ul style="list-style-type: none"> Biological context introduction Visual aids (infographics, simulations) Three-level task differentiation (basic, intermediate, advanced) Reflective journal prompts Formative quiz
Thermodynamics in Metabolism	<ul style="list-style-type: none"> Biological context introduction Visual aids (infographics, simulations) Three-level task differentiation (basic, intermediate, advanced) Reflective journal prompts Formative quiz
Acid-Base Equilibrium in Cellular Functions	<ul style="list-style-type: none"> Biological context introduction Visual aids (infographics, simulations) Three-level task differentiation (basic, intermediate, advanced) Reflective journal prompts Formative quiz
	<ul style="list-style-type: none"> Biological context introduction

Redox Reactions in Respiration and Photosynthesis	<ul style="list-style-type: none"> • Visual aids (infographics, simulations) • Three-level task differentiation (basic, intermediate, advanced) • Reflective journal prompts • Formative quiz
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RESULTS AND DISCUSSION

The needs analysis revealed that most students struggled with chemistry due to its abstract nature and a perceived lack of connection to biology. Additionally, the majority of students expressed a preference for contextual, visually rich learning materials as depicted in Figure 1.

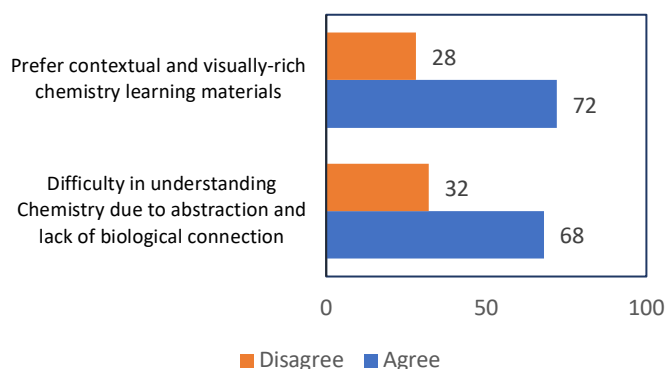


Figure 1. Students responses to Chemistry learning preferences

Figure 1 illustrates that the needs analysis identified significant challenges students face in understanding chemistry, with 68% indicating difficulty due to its abstract nature. This suggests that traditional teaching methods may fail to effectively bridge the gap between theoretical concepts and practical application. Moreover, the lack of perceived relevance to biology—a subject many students are more familiar with—further contributes to disengagement and reduced comprehension.

Additionally, 72% of students expressed a preference for learning materials that are contextual and visually engaging. This highlights a strong demand for resources that connect chemistry concepts to real-world biological phenomena, making the content more relatable and easier to understand. Visual aids, such as infographics and simulations, play a crucial role in this process by providing intuitive representations of complex ideas. These insights emphasize the need for a teaching approach that integrates interdisciplinary contexts, uses diverse visual tools, and caters to varied learning preferences to improve engagement and conceptual clarity in chemistry education. The module effectively integrated core chemistry concepts with biological examples to provide a meaningful and engaging learning experience. Topics such as the role of chemical bonds in DNA structure, buffer systems in blood,

and the stoichiometry of cellular respiration were contextualized to highlight the relevance of chemistry in understanding essential biological processes. This approach not only reinforced theoretical knowledge but also demonstrated its practical applications, fostering a deeper appreciation of chemistry's role in life sciences.

Module Design

To support diverse learning needs, the module incorporated a variety of teaching tools and strategies. Visual aids, including diagrams, infographics, animations, and video lectures, simplified complex ideas and catered to visual learners as can be observed in Figure 2. In addition, differentiated tasks allowed students to engage with exercises tailored to their abilities, ranging from guided practice for foundational skills to challenging tasks for advanced learners. Accessibility features, such as audio and video and simplified summaries, ensured inclusivity for students with learning difficulties or varied processing speeds. Each section concluded with reflective questions and self-assessment quizzes, encouraging students to evaluate their understanding and track their progress, promoting active learning and self-awareness.

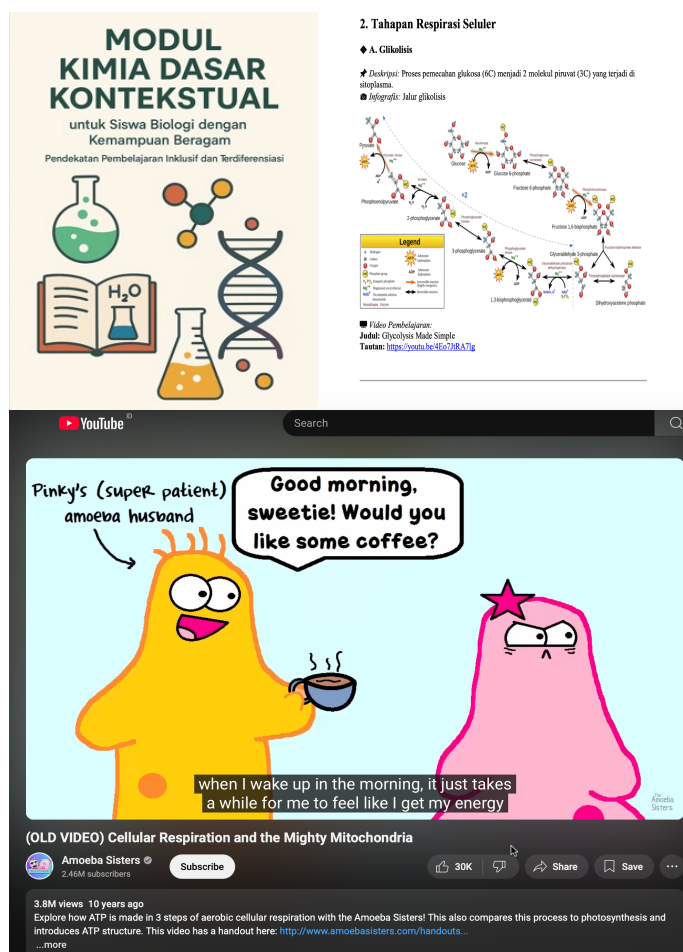


Figure 2. The module cover, visual illustration and learning video that linked from Youtube.

Implementation of the module and its effect on students' performance

After four weeks of implementing the module, its impact on student learning and engagement was both significant and multifaceted. The average student score improved from 59 on the pre-test to 78 on the post-test (Table 4), reflecting a substantial enhancement in conceptual understanding. This notable increase demonstrates the module's effectiveness in bridging gaps in comprehension by contextualizing abstract chemistry concepts through biological examples. By connecting these ideas to familiar phenomena, students were better equipped to grasp complex topics and apply their knowledge more effectively.

In addition to the score improvement, the module also excelled in fostering student engagement and equitable learning outcomes. A survey revealed that 84% of students found chemistry more relevant and comprehensible, emphasizing the importance of presenting chemistry within the context of real-world biological applications as depicted in Table 3. This approach not only sparked interest but also reinforced the practical value of chemistry in their academic and everyday lives. Importantly, students with lower initial proficiency showed remarkable progress, particularly in understanding solution concentrations, performing molar calculations, and interpreting chemical equations related to biological processes. This finding suggests that the module's differentiated tasks, accessibility features, and emphasis on formative assessments were instrumental in leveling the playing field, allowing all students to achieve meaningful growth regardless of their starting point.

Table 3. Student learning behavior before and after using the module

Observed Indicator	Before	After
Active participation in discussions	Low	High
Anxiety during chemistry tasks	High	Low
Problem-solving in biological chemistry	Moderate	High
Verbal explanation of chemical concepts	Limited	moderate

The observations indicated a significant improvement in student participation, confidence, and willingness to engage with challenging tasks, especially when chemistry was contextualized in biological systems. Observation data revealed improved participation and reduced anxiety. Students expressed increased confidence, particularly in solving chemical problems relevant to biological systems, supporting the effectiveness of integrating authentic assessments [10]. This shift in student behaviour suggests that when learning tasks are seen to be important and relevant to real-life circumstances, students are more likely

to participate actively and persevere in the face of a struggle. Authentic assessments, which are modelled after real-world problems, not only increase relevance but also allow students to demonstrate their comprehension in a variety of methods, such as experiments, presentations, or project-based assignments. These kinds of assessments alleviate the stress commonly associated with traditional testing, lowering anxiety and creating a more conducive learning environment.

Furthermore, students reported feeling more in charge of their learning experience since authentic assignments promoted self-reflection, teamwork, and problem-solving. Teachers also noticed increased consistency in participation from previously disengaged children, indicating a favorable shift in classroom dynamics. The overall learning environment became more student-centered and inclusive, demonstrating how carefully integrating authentic, biologically contextualized assessments can greatly improve both academic performance and emotional well-being in the chemistry classroom.

Table 4. The pre-test and post-test scores obtained by students before and after the implementation of the module

No	Indicator	Pre-Test Mean (%)	Post-Test Mean (%)	Gain (%)
1	Understanding chemical concepts	60	80	20
2	Application of chemistry in biological contexts	55	78	23
3	Problem-solving (chemical equations, calculations)	52	75	23
4	Interpretation of visuals (charts, diagrams)	65	83	18
5	Motivation and engagement (survey-based)	58	85	+27

Table 5 indicates the processed data results from the pre-test and post-test score tables of students (N=25) after implementing the contextual chemistry learning module. The significant improvement indicates that the module effectively enhanced students' understanding of fundamental chemistry concepts, particularly those related to biological contexts. The post-test score distribution became more uniform and was concentrated in the higher range (72–82), reflecting the collective achievement of learning outcomes. In addition, the smaller standard deviation suggests that the module positively impacted

across nearly all students, including those who had previously had scored lower

Table 5. Descriptive Statistics

Statistic	Pre-Test	Post-Test
Mean	58.76	77.76
Highest Score	63	82
Lowest Score	54	72
Median	59	78
Standard Deviation	~2.57	~2.45

The improvement in post-test results confirms that contextualization enhances comprehension of chemistry concepts among biology students [2],[16]. Students showed significant gains in conceptual understanding and problem-solving, affirming the value of real-world contexts. The findings highlight the necessity of creating instructional materials that are not only relevant to students' academic backgrounds, but also grounded in practical, everyday applications. Students can build mental models that aid deeper learning by connecting abstract chemical principles to biological processes and real-world circumstances. Furthermore, incorporating contextually rich problems promotes critical thinking and analytical reasoning, which are required for success in interdisciplinary subjects. The favorable findings of this study imply that contextualized learning not only improves short-term accomplishment, but also adds to the development of transferable skills that may be employed in a variety of scientific and professional settings. Furthermore, students reported improved engagement and confidence when approaching chemical assignments, emphasizing the motivational benefits of this instructional approach.

Visual and multimedia elements were identified as critical to student engagement [18]. These findings are consistent with prior studies which show that visual representations and digital simulations can improve learning in abstract disciplines like chemistry [6]. Such technologies assist bridge the gap between theoretical knowledge and practical understanding by transforming complex and often unseen chemical processes into dynamic, interactive formats. Visual aids like diagrams, animations, and 3D models help pupils understand molecular structures, reaction mechanisms, and spatial relationships more efficiently than text alone. Furthermore, digital simulations provide a secure and easily accessible environment for experimentation, allowing students to alter variables, monitor outcomes, and receive immediate feedback without the constraints of traditional laboratory settings. This multimodal method accommodates a variety of learning preferences, particularly for visual and kinesthetic learners, and so promotes inclusive educational practices. Furthermore, the use of multimedia promotes active learning and sustained attention, both of which are

required to grasp difficult scientific information. Overall, integrating visual and digital aspects improves comprehension while also creating a more engaging and equitable learning environment for all students.

Differentiated tasks allowed students with varying prior knowledge to engage with content meaningfully. Low-performing students were particularly responsive to scaffolded activities, a finding supported by inclusive education research [9]. These scaffolded assignments provided step-by-step instructions, allowing students to gradually gain confidence and competence as they worked through the content. By breaking down complex topics into manageable chunks and providing targeted support, the module reduced cognitive overload and boosted students' willingness to actively participate in learning tasks. Furthermore, higher-achieving students profited from extension activities that required them to apply concepts in new circumstances, fostering deeper learning and critical thinking. The flexible framework of differentiated instruction meant that all children, regardless of skill level, received adequate support and challenge [20]. This method is consistent with the principles of Universal Design for Learning (UDL), which advocate for providing diverse modes of representation, interaction, and expression to accommodate learner heterogeneity. As a result, differentiated assignments not only improved academic performance, but also created a more inclusive and supportive classroom atmosphere in which each student could thrive based on their unique requirements and pace.

The hybrid format and module structure promoted student autonomy. Self-paced sections empowered students to review difficult content at their own pace, consistent with UDL principles [8].

Student Perception Toward the Contextual Module

After completely implemented the module, students were asked to answer a Likert scale questionnaire to evaluate their feeling toward the module. They were also required to perform reflection and perception regarding the module and its implementation. The results are depicted in Figure 3, Table 6 and Table 7.

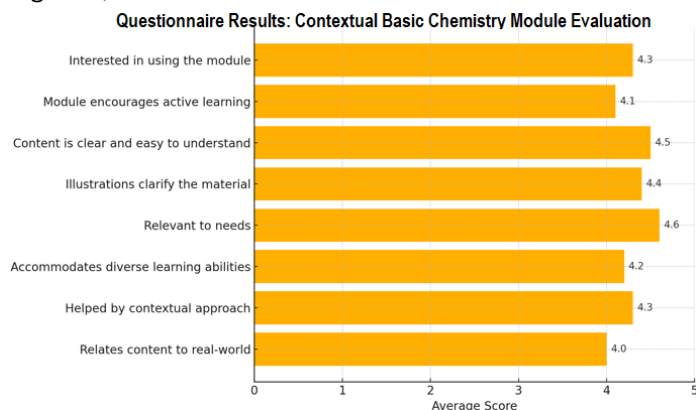


Figure 3. Students' opinion toward the contextual module of chemistry

Figure 3 demonstrates that students overwhelmingly viewed the contextual chemistry module as highly effective and relevant to their learning needs. Most aspects of the module received qualitative grades of 4 (good) or 5 (excellent), reflecting its success in engaging students and enhancing their understanding of chemistry concepts.

Students particularly appreciated the module's alignment with their academic and practical needs, rating its relevance as excellent. They also found the content clear and well-supported by visuals, which they graded as excellent for simplifying complex material and clarifying key ideas. The use of a contextual approach to connect chemistry with real-world biological phenomena was highly valued, receiving a good to excellent grade, underscoring its role in making abstract concepts relatable. Moreover, the module's inclusivity in accommodating diverse learning abilities and its encouragement of active learning were recognized as good, highlighting its ability to cater to various student needs effectively. Overall, the qualitative feedback underscores the module's strong impact on both engagement and comprehension, with minor areas for further improvement in relating content to real-world applications.

Table 6. Student Reflections on the Contextual Module

Reflection Theme	Sample Student Comments
Relevance to biology	"Now I realize chemistry is essential in understanding metabolism."
Helpfulness of visual media	"The animations made it easier to understand chemical reactions."
Increased self-confidence	"I used to feel anxious, but now I can solve problems on my own."

Table 7. Student perceptions toward the module (N=25)

Evaluation Aspect	Positive response (%)
Module helped relate chemistry to biology	84
Visual and multimedia features were helpful	88
Tasks were appropriate for different ability levels	80
The module encouraged active learning	76
Prefer this module over traditional textbook approaches	92

The data from Tables 6 and 7 reveal a clear pattern of positive student reflections and perceptions toward the contextual chemistry module, highlighting its effectiveness in enhancing understanding, engagement, and confidence. Students expressed that the module's integration of chemistry with biological concepts significantly improved their appreciation of the subject's relevance, with one

student stating, "Now I realize chemistry is essential in understanding metabolism." This reflects the module's success in demonstrating practical applications of abstract chemistry concepts, as corroborated by 84% of students agreeing that the module effectively related chemistry to biology.

The use of visual and multimedia features emerged as another standout strength. Students praised animations and other media for simplifying complex processes, with 88% affirming their helpfulness. This suggests that these tools played a vital role in breaking down difficult topics and fostering clearer understanding. Furthermore, the module promoted inclusivity and confidence, as reflected by comments like "I used to feel anxious, but now I can solve problems on my own," and the 80% approval rating for tasks designed to suit varied ability levels. Notably, 92% of students preferred this module over traditional textbook approaches, emphasizing its ability to make learning more engaging and tailored to modern educational needs. Overall, the data shows that the module was well-received and effective in transforming students' attitudes toward chemistry learning.

Although the sample size was limited, the module demonstrated clear benefits in improving engagement, comprehension, and equitable access to chemistry learning. Future research could explore its scalability and integration into other life science programs [5]. The integration of context-based learning approaches has been shown to positively impact cognitive, affective, psychomotor, and social aspects of students' learning in chemistry [4]. By situating chemical concepts within biological contexts, students can better relate to and understand the material, leading to improved learning outcomes.

Universal Design for Learning (UDL) frameworks have been instrumental in creating inclusive educational environments. Implementing UDL principles ensures that learning materials are accessible and engaging for all students, regardless of their abilities or backgrounds [2].

The use of technology-supported differentiated instruction has emerged as a trend in biology education, providing diverse methods and content to cater to individual learning needs. Such approaches have been effective in enhancing student engagement and achievement [1]. The development of customized pedagogical kits for differentiated instruction in chemistry classrooms has shown to improve students' self-efficacy and attitudes towards the subject. These kits allow for tailored learning experiences that address individual student needs [12]. A systematic literature review on context-based chemistry learning highlights its effectiveness in enhancing students' critical thinking skills. By connecting chemical concepts to real-life situations, students develop deeper understanding and analytical abilities [4].

In addition, the implementation of case-based learning in science education has been effective in promoting higher-order thinking skills among students. By engaging with real-world scenarios, students can apply their knowledge in practical contexts, enhancing their problem-solving abilities [2, 3]. The similar work like using flipped classroom modules in chemistry education facilitates higher-order thinking by allowing students to engage with content before class and apply their knowledge during in-class activities. This approach promotes active learning and deeper understanding of complex concepts [15].

The integration of inclusive teaching practices in science education is essential for addressing the diverse needs of students. By adopting inclusive pedagogies, educators can create learning environments that support all students in achieving their academic potential [1].

The results of this study indicate that the development of a contextual-based basic chemistry module incorporating inclusive and differentiated learning approaches has a positive impact on improving conceptual understanding among biology students with diverse abilities. This approach successfully bridges gaps in comprehension among students through the integration of relevant biological contexts, differentiated material delivery strategies, and the provision of flexible and adaptive learning environments.

Practically, the learning model developed fosters a more equitable and responsive educational environment tailored to individual student needs. This aligns with the principles of inclusive education and Universal Design for Learning (UDL), which emphasize accessibility, engagement, and success for all learners without exception. The implementation of this module also strengthens the role of instructors as facilitators in student-centered learning [11].

These findings reinforce previous literature suggesting that context-based chemistry instruction not only enhances cognitive aspects but also promotes students' affective and social engagement. Linking basic chemistry content to biological phenomena familiar to students has proven effective in building relevance, increasing interest, and deepening conceptual understanding.

In the context of higher education chemistry instruction, the application of tiated strategies supported by technology represents a significant innovation. Approaches such as adaptive worksheets, interactive learning videos, and formative assessments with feedback have effectively increased learning motivation and academic achievement among students with varying learning paces [19].

Previous research also highlights that the development of pedagogical kits or learning aids tailored to students' learning profiles can enhance self-efficacy and foster positive attitudes toward chemistry learning. By breaking down complex topics into smaller, more manageable

learning chunks, these kits accommodate individual pace and foster progressive mastery of material. Furthermore, when students believe that the resources have been prepared with their individual requirements in mind, their motivation and sense of belonging in the learning environment improve dramatically. Teachers also benefit from these technologies since they provide structured direction for differentiated instruction and allow for more efficient classroom management. In inclusive classrooms, such pedagogical aids serve not only as instructional support but also as empowerment tools, allowing all students—including those with cognitive, emotional, or linguistic challenges—to engage more confidently and independently with abstract scientific content. As a result, the use of well-designed, learner-centered teaching aids helps to create a more equal and successful chemistry education landscape.

CONCLUSION

The use of visually structured and modular contextual teaching materials accelerates understanding, especially among students with learning difficulties. These findings contribute to the development of basic chemistry instructional materials that are not only contextualized but also grounded in the principles of inclusion and differentiation. Future recommendations include large-scale implementation of the module, integration of AI-based adaptive technologies, and interdisciplinary collaboration to support synergy between pedagogy, content, and technology for equitable higher education.

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