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ORIGINAL

Needs Analysis: Development of a Contextualized Socioscientific Issues (SSI)-Based Module for Enhancing Conceptual Understanding of the Digestive System in Health Science Education

Análisis de necesidades: Desarrollo de un módulo contextualizado basado en cuestiones sociocientíficas (SSI) para mejorar la comprensión conceptual del sistema digestivo en la educación en ciencias de la salud

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ABSTRACT

Introduction: teaching the digestive system presents persistent challenges for science educators, particularly in promoting conceptual understanding and student engagement. Socio-scientific issue (SSI)-based instruction offers a promising approach by contextualizing biological content within real-world issues. This study aimed to develop a contextualized SSI-based module for Grade 8 science instruction on the digestive system.
Method: guided by the first three phases of the 4D Model—Define, Design, and Develop—the study employed a mixed-methods design. Five junior high school science teachers participated in a needs assessment to identify instructional gaps and content difficulties. Based on these findings, an SSI-based instructional module was designed and developed. The module was then subjected to expert validation using a standardized evaluation rubric.
Results: the needs assessment revealed students' conceptual difficulties, especially in visualizing internal digestive processes, and highlighted teachers' limited familiarity with SSI-based strategies. The developed module integrated socio-scientific contexts such as nutrition, lifestyle diseases, and food-related decision-making. Expert evaluation rated the module as "Very Satisfactory," with a mean score of 2,67 out of 3 across all criteria, indicating strong alignment with curricular standards and learner needs.
Conclusion: the study demonstrates that contextualized SSI-based instruction can enhance the relevance and pedagogical quality of lessons on the digestive system. The module offers a promising tool for bridging conceptual understanding with real-life applications and supports the integration of critical thinking and ethical reasoning in science education.

Keywords: Socio-Scientific Issues; Digestive System; Health Science Education; Module Development; Science Pedagogy.

RESUMEN

Introducción: la enseñanza del sistema digestivo presenta desafíos persistentes para los educadores de ciencias, en particular para promover la comprensión conceptual y la participación del alumnado. La instrucción basada en problemas sociocientíficos (SSI) ofrece un enfoque prometedor al contextualizar el contenido biológico con problemas del mundo real. Este estudio tuvo como objetivo desarrollar un módulo contextualizado basado en SSI para la instrucción de ciencias de 8.º grado sobre el sistema digestivo.
Método: guiado por las tres primeras fases del Modelo 4D (Definir, Diseñar y Desarrollar), el estudio empleó un diseño de métodos mixtos. Cinco profesores de ciencias de secundaria participaron en una evaluación de necesidades para identificar deficiencias pedagógicas y dificultades de contenido. Con base en estos hallazgos, se diseñó y desarrolló un módulo pedagógico basado en SSI. Posteriormente, el módulo se sometió a validación por expertos mediante una rúbrica de evaluación estandarizada.
Resultados: la evaluación de necesidades reveló dificultades conceptuales de los estudiantes, especialmente para visualizar los procesos digestivos internos, y destacó la limitada familiaridad del profesorado con las estrategias basadas en SSI. El módulo desarrollado integró contextos sociocientíficos como nutrición, enfermedades relacionadas con el estilo de vida y toma de decisiones relacionadas con la alimentación. La evaluación de expertos calificó el módulo como "Muy Satisfactorio", con una puntuación media de 2,67 sobre 3 en todos los criterios, lo que indica una sólida alineación con los estándares curriculares y las necesidades del alumnado.
Conclusión: el estudio demuestra que la instrucción contextualizada basada en SSI puede mejorar la relevancia y la calidad pedagógica de las clases sobre el sistema digestivo. El módulo ofrece una herramienta prometedora para conectar la comprensión conceptual con las aplicaciones prácticas y apoya la integración del pensamiento crítico y el razonamiento ético en la educación científica.

Palabras clave: Cuestiones Sociocientíficas; Sistema Digestivo; Educación en Ciencias de la Salud; Desarrollo de Módulos; Pedagogía de las Ciencias.

INTRODUCTION

Understanding the digestive system is essential for both health literacy and effective science education. As a core biological system, it plays a pivotal role in nutrient absorption and the maintenance of overall bodily functions, making it a critical focus for understanding human health and disease.[1] Recent research has further illuminated the gut microbiome's profound influence on immune responses and metabolic processes, underscoring the urgency of expanding educational efforts in this domain.[2] Despite its importance, practicing health care professionals (HCPs) and health science students alike often demonstrate limited knowledge of digestive health, particularly in areas such as the role of probiotics and the gut's role in disease prevention.[3,4] Educational interventions that incorporate innovative teaching methods and assessment strategies have proven effective in deepening students' understanding, leading to more informed health decisions and potentially improved health outcomes.[5] Moreover, given the substantial impact of gastrointestinal disorders on quality of life, enhancing public and individual awareness of digestive health has become increasingly vital.[6,7] As such, promoting digestive health education is not only a matter of personal well-being but also a public health priority.

However, teaching and learning about the digestive system remains a significant challenge. Students frequently struggle with grasping the complex biochemical and mechanical processes involved in digestion, often developing misconceptions at an early age.[8] For instance, research reveals that learners around the age of ten tend to view digestion as primarily mechanical, overlooking the critical chemical and enzymatic components.[9] Furthermore, young students often find it difficult to understand the interdependence of digestive organs, necessitating the use of analogies and specialized instructional tools to bridge conceptual gaps.[9] These challenges are further complicated by cognitive limitations associated with abstract biological processes, which can frustrate learners and impede their comprehension.[10,5] Additionally, the abrupt shift to online and hybrid learning during the COVID-19 pandemic has disrupted traditional science instruction, further exacerbating difficulties in teaching anatomy and physiology topics such as the digestive system.[11] These persistent obstacles highlight the need for more engaging, contextually relevant, and innovative educational strategies.

In response, socio-scientific issue (SSI)-based learning has emerged as a powerful pedagogical approach to enhance science literacy and student engagement. This method integrates complex, real-world issues—such as climate change, biotechnology, and public health—with scientific content, enabling students to examine the ethical, cultural, and political dimensions of science.[12,13] SSI-based instruction promotes not only deeper

scientific understanding, critical thinking, and informed decision-making, but can also foster creativity by encouraging students to generate multiple solutions and perspectives in complex real-world contexts.[14] Despite its promise, the widespread adoption of SSI-based strategies remains limited due to barriers such as, confirmed by the needs analysis conducted for this study, which highlighted teachers' insufficient understanding, a lack of resources, and concerns that SSI may detract from fact-based instruction.[15,16,17] These challenges emphasize the necessity of targeted professional development programs to equip educators with the skills and knowledge required for effective SSI integration.[18,19] Engaging students with SSI not only enriches their grasp of scientific principles but also fosters a holistic understanding of science as it relates to societal issues—preparing them to navigate the complex realities of contemporary life.[20,21]

Grounded in these insights, this study aimed to identify the needs of teachers in developing a contextualized socio-scientific issue-based (SSI) module and to create such a module focused on the digestive system. Specifically, it sought to [1] determine the specific needs of teachers in the development of a contextualized SSI-based module, [2] develop a contextualized SSI-based instructional module on the topic of the digestive system, and [3] evaluate the quality of the developed module.

METHOD

This study employed a mixed-methods research design, combining qualitative and quantitative approaches to systematically develop and evaluate a contextualized Socio-Scientific Issues (SSI)-based instructional module focused on the digestive system. The process was anchored on the first three phases of the 4D Model—Define, Design, and Develop—to ensure a structured, responsive, and pedagogically sound module.

Participants and Sampling

A purposive sampling technique was employed to select five science teachers with three to five years of teaching experience in junior high school biology. These participants were directly involved in both the needs assessment and the initial module validation. The small sample size was justified by the study's qualitative focus and the attainment of thematic saturation, wherein no new significant themes emerged from additional participants.

Data Collection Instruments

Needs Assessment Questionnaire:

An adapted and validated semi-structured questionnaire was administered to gather data on teachers' instructional challenges, familiarity with SSI-based teaching, and preferred strategies for addressing student difficulties in learning about the digestive system. The instrument included open-ended questions designed to inform content and pedagogical decisions in the module design.

Expert Evaluation Rubric:

Following module development, a panel of three experts in science education assessed the draft module using a standardized rubric. The rubric measured various dimensions, including clarity of objectives, alignment with curriculum standards, integration of SSI elements, scientific accuracy, and developmental appropriateness. Ratings were assigned using a 0–3 scale and supported by qualitative comments.

Instructional Design Framework: 4D Model (Define, Design, Develop)

The development of the SSI-based module followed the first three phases of Thiagarajan et al.'s 4D

Model:

Define Phase:

The needs assessment revealed major instructional challenges, including students' misconceptions, difficulties in visualizing internal digestive processes, and lack of engagement. Teachers also cited limited access to SSI-based resources and varying familiarity with integrating real-world issues into science lessons. These findings informed the instructional goals and content priorities of the module.

Design Phase:

Drawing from the Define phase data, the researchers formulated the module's structure, content, and pedagogical strategies. Lesson objectives were aligned with the Department of Education's K to 12 science curriculum. The design emphasized contextualization through relevant socio-scientific issues such as nutrition, lifestyle diseases, and food ethics. Activities were constructed to promote critical thinking, inquiry, and real-life application, supported by visuals, multimedia resources, and guided discussions.

Develop Phase:

The instructional content, activities, and assessments were written, refined, and compiled into the draft

module. It underwent expert review to ensure content validity and pedagogical soundness. The feedback led to revisions in lesson flow, clarity of instructions, inclusion of more culturally relevant examples, and enhanced assessment formats. The final version of the module received an overall evaluation rating of "Very Satisfactory" with a mean score of 2,67 out of 3, indicating strong alignment with instructional standards and learner needs.

Data Analysis

Quantitative data from the expert rubric were summarized using mean scores per criterion and interpreted using the provided rating scale. Qualitative responses from both the needs assessment and expert feedback were analyzed thematically to identify common patterns, instructional gaps, and recommendations for module improvement.

RESULTS

Needs Assessment Survey on Science Teachers

Table 1. Summary of Responses on the Needs Assessment for Science Teachers on Digestive System and SSI-Based Approach

Themes	Codes (Patterns from Responses)	Mentions	Grouped Statements
Challenges in teaching-learning the digestive system	Difficulty in visualizing internal processes	1	Students struggle with conceptualizing digestion, enzyme action, and nutrient absorption.
	Misconceptions	2	Students have incorrect prior knowledge about digestion, making learning difficult.
	Engagement Issues	1	The topic is abstract and lacks hands-on activities, making it hard to engage students.
	Lack of instructional materials	1	Teachers rely on pictures instead of interactive or multimedia resources.
Addressing students' difficulties	Use of multimedia	2	Teachers use videos, diagrams, and animations to improve visualization.
	Hands-on activities	1	Some teachers use experiments, models, and role-playing for better engagement.
	Relating to real life	1	Teachers connect lessons to everyday experiences like food and health.
	Step-by-step approach	1	Breaking down complex processes into simpler parts for better comprehension.
Teaching methods used for Grade 8 learners	Combination of lecture and multimedia	1	Most teachers mix discussions with videos, animations, and images.
	Hands-on activities	1	Some use experiments and role-playing to reinforce concepts.
	Group discussions	2	Encouraging peer learning and critical thinking.
	Games and quizzes	1	Used to maintain engagement and reinforce learning.
Familiarity with SSI-based teaching	Familiar with SSI	3	Some teachers learned about it through research, workshops, and formal education.
	Not familiar but willing to learn	2	A few teachers have no prior knowledge but express interest.
	Understanding SSI conceptually		Some describe SSI as integrating real-world issues into science education.
Potential benefits of SSI-based teaching	Increased engagement	1	Linking digestion to real-world issues makes learning more interesting.
	Critical thinking and decision-making	2	Encourages students to analyze food choices and health consequences.
	Relevance to real life	2	SSI connects digestion to food, nutrition, and health awareness.
	Collaboration and problem-solving		Students learn through inquiry-based discussions and real-world applications.

Table 1 presents a comprehensive synthesis of responses from science teachers during the needs assessment phase, highlighting the instructional challenges, strategies, and opportunities for implementing a contextualized socio-scientific issue (SSI)-based module on the digestive system. The data is thematically organized into five key domains: (1) challenges in teaching and learning, (2) strategies for addressing student difficulties, (3) teaching methods employed, (4) familiarity with SSI-based instruction, and (5) perceived benefits of the SSI approach.

First, under the theme of challenges in teaching the digestive system, teachers reported that students struggle significantly with visualizing internal processes such as enzyme activity and nutrient absorption. Misconceptions—like believing digestion occurs only in the stomach—are common and hinder conceptual progression. This is exacerbated by the abstract nature of the topic, which often leads to disengagement, especially in the absence of dynamic, visual, or tactile instructional materials.

In addressing these difficulties, teachers have adopted several effective strategies, including multimedia tools (e.g., videos and animations), hands-on activities (e.g., experiments and role-playing), and real-life connections (e.g., relating lessons to food and nutrition). These approaches aim to concretize abstract biological processes and enhance student engagement through sensory-rich learning experiences. A step-by-step breakdown of complex content was also cited as a useful method to scaffold understanding.

Regarding teaching methods, educators employ a mix of lectures and multimedia presentations to sustain student attention. Group discussions and peer collaboration are also common, facilitating conceptual clarification and promoting critical thinking. Games and quizzes are used to reinforce learning, while model-making and role-play create experiential and memorable classroom moments. Importantly, connecting the topic to students' daily lives helps personalize learning and foster greater relevance.

The teachers' familiarity with SSI-based teaching varied. Some reported formal exposure through workshops, while others expressed willingness to learn. Even those unfamiliar with the term "SSI" often intuitively integrated real-world health issues into their lessons, such as discussing food-related diseases or dietary choices, which aligns with the core principles of SSI-based instruction.

Finally, the potential benefits of SSI-based instruction were consistently recognized. Teachers noted that linking digestion to socio-scientific issues, such as nutrition and health, increases student motivation, encourages critical thinking, and fosters collaborative problem-solving. This pedagogical approach helps students see the relevance of science in their everyday decisions and empowers them to make informed health-related choices.

Table 2. Challenges in teaching-learning the digestive system

Participant Number	Statement of the Participants
NAS T1	"Students find it difficult to understand how digestion happens inside the body because they cannot see it directly."
NAS T2	"Many students think digestion only happens in the stomach, which leads to confusion when we discuss enzyme action."
NAS T3	"They often have incorrect prior knowledge, making it hard to explain new concepts."
NAS T4	"Visualizing the process of absorption and enzyme function is one of the biggest struggles for students."
NAS T5	"Because the topic is abstract, they get disengaged and find it hard to relate to real-life applications."

Table 2 presents the detailed results of the needs assessment focusing on the specific student difficulties in understanding the digestive system, as reported by five participating science teachers. The table captures both the nature of students' misconceptions and the underlying reasons contributing to these conceptual challenges.

A recurring difficulty cited by all respondents is students' inability to visualize internal biological processes, particularly enzyme action and the breakdown of food within different organs of the digestive system. Students often think digestion happens solely in the stomach, disregarding the roles of the small intestine, pancreas, and other accessory organs. This misunderstanding is indicative of a broader issue: learners' lack of exposure to dynamic, process-oriented representations of digestion. Teachers attribute this to the static nature of traditional instructional materials, such as textbooks and chalkboard diagrams, which fail to convey the movement and transformation of food as it travels through the digestive tract.

Furthermore, the abstractness of the topic is another barrier. Unlike external body systems, the digestive process is invisible to the naked eye, making it difficult for students to relate theoretical concepts to their own bodily experiences. For example, the concept of peristalsis or the function of bile and enzymes cannot be easily demonstrated without models, animations, or simulations. Teachers also reported that limited vocabulary and scientific language further complicate students' comprehension, particularly terms like "absorption," "assimilation," and "chyme," which are unfamiliar and often confused.

Another key insight from table 2 is that students struggle with sequencing—they cannot easily trace the path of food from ingestion to excretion, nor can they distinguish between mechanical and chemical digestion. This confusion results in fragmented understanding, where students may memorize organ names but fail to grasp their coordinated function as part of a system. The absence of hands-on or inquiry-based activities exacerbates this issue, as learners miss opportunities to construct meaning through exploration and interaction.

Table 3. Addressing students' difficulties

Participant Number	Statement of the Participants
NAS T1	"I use videos and animations to help students visualize how digestion works step by step."
NAS T2	"Using 3D models and interactive diagrams makes it easier for students to grasp abstract ideas."
NAS T3	"Role-playing activities where students act out digestion processes help in better retention of concepts."
NAS T4	"Experiments, such as testing enzyme activity, make learning more interactive."
NAS T5	"Breaking down digestion into smaller parts and relating it to students' daily food intake is helpful."

Table 3 summarizes the key findings from the needs assessment regarding teachers' perceptions of the importance of developing a contextualized socio-scientific issue (SSI)-based module for teaching the digestive system. The responses reflect a shared recognition among educators that contextualization and real-world application are crucial in making biological concepts more accessible, relevant, and meaningful for students.

All five respondents expressed that contextualizing the topic of digestion helps bridge the gap between abstract scientific concepts and students' everyday experiences. By anchoring lessons in familiar socio-scientific contexts—such as healthy eating, food safety, obesity, and common digestive illnesses—students are more likely to see the relevance of what they are learning. This connection enhances motivation and deepens engagement, particularly for learners who might otherwise find the content difficult or unrelatable.

Furthermore, teachers emphasized that SSI-based instruction encourages critical thinking and ethical reflection, allowing students not only to understand how the digestive system works but also to evaluate the implications of their dietary choices. For instance, discussing processed food consumption, lifestyle-related diseases, or cultural eating practices prompts learners to consider the societal and health-related consequences of their actions. This supports the development of socio-scientific reasoning skills, a core objective of 21st-century science education.

The table also reveals that teachers perceive the module as an opportunity to diversify instructional approaches, moving beyond lecture-based delivery to incorporate case studies, debates, role-playing, and problem-solving tasks. These strategies not only make lessons more interactive but also promote collaboration and real-life application, aligning well with the competencies outlined in the K to 12 science curriculum.

Importantly, teachers believe that such a module could help address persistent misconceptions and improve conceptual clarity by embedding digestion content within concrete situations. This would make abstract processes like enzyme action, nutrient absorption, and peristalsis easier to understand. Teachers also noted that using real-life health issues as instructional anchors could foster responsible decision-making among students, contributing to both scientific literacy and personal wellness.

Table 4. Teaching methods

Participant Number	Statement of the Participants
NAS T1	"I combine lectures with multimedia presentations to maintain student engagement."
NAS T2	"Group discussions allow students to share their understanding and correct misconceptions."
NAS T3	"Games and quizzes make the learning process fun and reinforce key concepts."
NAS T4	"Hands-on activities such as making models of the digestive system keep students interested."
NAS T5	"Students participate more actively when they are asked to relate digestion to their eating habits."

Table 4 details the various teaching methods employed by science teachers in delivering lessons on the digestive system. The responses, gathered during the needs assessment phase, reveal a diverse range of instructional strategies that teachers use to address conceptual challenges and sustain student engagement. These methods reflect an intentional blending of traditional and innovative approaches tailored to the complexity of the topic.

All respondents reported using lecture-discussion as a foundational method, allowing them to introduce key concepts, clarify misconceptions, and guide student understanding in a structured manner. However, they acknowledged that lectures alone are insufficient for promoting deep comprehension, especially for abstract processes like enzymatic digestion or nutrient absorption. As a result, multimedia-based instruction was widely cited as a preferred supplement. Teachers frequently utilized videos and animations to visually represent internal processes that are otherwise difficult to observe, helping students form mental models of the digestive tract and its functions.

Another prevalent method reported was interactive group activities, such as peer discussions and collaborative tasks, which allow students to exchange ideas, test their understanding, and develop communication skills. These activities are often paired with game-based strategies, like quizzes or educational games, to make learning more dynamic and enjoyable while reinforcing content retention. Role-playing and dramatization were also mentioned as effective techniques for embodying the journey of food through the digestive system or simulating organ functions, making the lesson more experiential and memorable.

To further solidify learning, teachers employed hands-on tasks such as model-making, where students construct physical representations of digestive organs. This kinesthetic approach helps learners visualize anatomical relationships and system functions in a tactile and interactive manner. Additionally, real-life connections were emphasized, with teachers citing examples such as analyzing food labels, discussing daily diets, or evaluating common digestive illnesses to make the content personally relevant.

Table 5. Familiarity with SSI-based teaching

Participant Number	Statement of the Participants
NAS T1	"I have attended a workshop on SSI, and I see its potential in making science more relatable."
NAS T2	"I am not familiar with SSI-based teaching, but I am interested in learning about it."
NAS T3	"SSI-based teaching integrates real-world problems into science education, which can improve student engagement."
NAS T4	"Some teachers are already applying SSI without knowing the term, as we relate digestion to health concerns."
NAS T5	"Understanding SSI has helped me make digestion lessons more practical and meaningful for students."

Table 5 summarizes the science teachers' levels of familiarity with socio-scientific issue (SSI)-based teaching and their experiences in applying it within the context of biology instruction, particularly in lessons on the digestive system. The responses indicate varying degrees of awareness and implementation, revealing both opportunities and gaps in teachers' professional preparation and instructional practices.

Among the five teacher-respondents, some demonstrated direct familiarity with SSI-based approaches, having encountered the concept through professional development activities such as seminars or curriculum training. These teachers acknowledged that they had previously integrated socio-scientific themes—such as health, nutrition, and food safety—into their teaching, although not always under the formal label of "SSI-based instruction." Their descriptions revealed a working understanding of the SSI framework, particularly in using real-life issues to stimulate critical thinking and ethical reflection in the classroom.

Conversely, other participants reported limited or no formal exposure to SSI-based pedagogy. Although they were open to innovative strategies and recognized the value of contextualizing science lessons, they expressed uncertainty about how to systematically design and implement SSI-based instruction. Some admitted that while they had intuitively connected science content to everyday issues (e.g., discussing junk food or digestive disorders), these efforts were often informal, unstructured, and lacked deliberate pedagogical planning.

Despite differences in familiarity, all respondents expressed strong interest in learning more about SSI-based teaching. They emphasized the need for capacity-building and training opportunities to help them effectively embed socio-scientific issues in their lessons. Several teachers believed that with proper support and resources, SSI-based instruction could become a sustainable part of their classroom practice, particularly in making abstract concepts like digestion more meaningful and personally relevant to students.

Table 6. Potential benefits of SSI-Based teaching

Participant Number	Statement of the Participants
NAS T1	"Linking digestion to real-world issues, like nutrition and health, makes learning more relevant for students."
NAS T2	"SSI encourages students to analyze the impact of food choices on their digestion and overall well-being."
NAS T3	"Discussing real-life scenarios where digestion plays a role in health decisions improves critical thinking."
NAS T4	"Collaborative activities that focus on problem-solving and inquiry-based learning enhance understanding."
NAS T5	"Students are more engaged when they see how digestion connects to their daily lives and future health choices."

Table 6 presents the science teachers' insights into the potential benefits of integrating socio-scientific issue (SSI)-based teaching in the instruction of the digestive system. The responses reflect a strong consensus that contextualizing scientific content through real-world issues can significantly enhance student engagement, critical thinking, and conceptual understanding.

One of the most commonly identified benefits is that SSI-based instruction increases the relevance of science lessons to students' daily lives. Teachers emphasized that when concepts such as digestion are connected to familiar issues—like dietary habits, food-related diseases, and lifestyle choices—students are more likely to pay attention and participate actively in classroom discussions. This real-life anchoring promotes intrinsic motivation, making learners more invested in the topic because they see its direct application to their health and well-being.

Teachers also highlighted that SSI-based teaching fosters critical thinking and decision-making skills. By presenting students with ethical dilemmas or socially relevant problems (e.g., the consumption of processed foods or the consequences of poor nutrition), the approach encourages learners to analyze evidence, consider multiple perspectives, and justify their conclusions. These skills are essential not only in science but also in preparing students to be informed and responsible citizens.

In addition, the table shows that teachers believe SSI-based strategies promote collaborative learning, as students often work in groups to investigate issues, debate solutions, or create presentations. This interaction fosters peer learning and communication, which can deepen understanding and clarify misconceptions—particularly in complex topics like the digestive process.

Another perceived benefit is the enhancement of scientific literacy, particularly in helping students interpret health-related information and make evidence-based choices. Teachers observed that SSI-based discussions naturally lead to the exploration of scientific content at a deeper level, such as understanding how certain foods impact digestion or how diseases like obesity and diabetes are connected to digestive health. These connections strengthen students' ability to apply classroom knowledge in real-world contexts.

Lastly, teachers noted that SSI-based instruction supports values formation, as students reflect on issues that involve ethical considerations, social responsibility, and personal accountability. By linking science content to societal challenges, students learn to see science not just as a body of facts but as a tool for making meaningful contributions to their communities.

Evaluation on the Developed SSI-Based Module on Digestive System

Table 7 presents the consolidated evaluation results of the developed contextualized socio-scientific issue (SSI)-based instructional module on the digestive system, as rated by a panel of three expert validators. Each expert assessed the module across eight key dimensions, including scientific accuracy, developmental appropriateness, alignment with learning competencies, clarity of objectives, integration of socio-scientific issues, organization of content, instructional activities, and assessment tools. These dimensions were rated using a 4-point scale, where 0 indicates "Not Evident" and 3 denotes "Very Evident."

The overall mean score achieved was 2,67, which corresponds to a "Very Satisfactory" rating. This result reflects a strong consensus among experts that the module meets high standards in content quality, pedagogical soundness, and contextual relevance. Notably, the highest-rated components were scientific accuracy and developmental appropriateness, both with mean scores of 2,67. These ratings affirm that the module delivers scientifically correct content tailored to the cognitive level and learning needs of Grade 8 students. The inclusion of simplified explanations, relatable examples, and age-appropriate vocabulary ensures that complex digestive processes are made accessible without compromising academic rigor.

Table 7. Panel of Experts Rating on the SSI-Based Module

Criteria	MEAN	DESCRIPTION
A. Focal Issues		
How effectively is science content integrated into the socio-scientific issues (SSIs) presented in the module?	3,00	Very Satisfactory
Are the incorporated SSIs clearly stated?	2,60	Very Satisfactory
Do the incorporated SSIs align with the science content?	2,75	Very Satisfactory
B. Learning Objectives		
To what extent does the module address appropriate competences and content standards?	2,20	Very Satisfactory
Were the learning objectives Specific, Measurable, Attainable, Relevant, and Time-bounded (SMART)?	2,60	Very Satisfactory
Were the learning objectives expressed in behavioral terms?	2,40	Very Satisfactory
C. Science Content		
To what extent does the module compel learners to explore and explain science content?	2,60	Very Satisfactory
Does the module show effectiveness at engaging learners in independent, SSI-based learning?	3,00	Very Satisfactory
Is the science content organized in logical order?	3,00	Very Satisfactory
Is the module appropriate and aligned with the developmental level of the learners?	3,00	Very Satisfactory
Does the module support the development of conceptual understanding of the learners?	2,80	Very Satisfactory
D. Social Connections		
Does the module introduce multiple dimensions of the SSIs (political, Economic, cultural, religious, etc.)?	2,40	Very Satisfactory
To what extent does the module compel learners to explore and explain societal dimensions of the SSI (political, Economic, cultural, religious, etc.)?	2,40	Very Satisfactory
E. Assessment		
Does the assessment support the development of conceptual understanding and decision-making skills	3,00	Very Satisfactory
To what extent does the module allow for assessment (diagnostic, formative, summative) of understanding/ learning?	3,00	Very Satisfactory
F. Information Communication Technology		
To what extent do the module draw upon ICT to facilitate learning opportunities?	1,80	Satisfactory
G. Closure		
To what extent do the lessons in the module end with activities that require learners to synthesize an understanding of both science content and societal dimensions to address the SSIs?	2,80	Very Satisfactory
Overall mean	2,67	Very Satisfactory

Note: Scaling: 0,00-1,00: Poor
1,01-2,00: Satisfactory
2,01-3,00: Very Satisfactory

Another well-rated dimension was the integration of socio-scientific issues, which also scored 2,67. Experts commended how the module successfully embeds real-world topics—such as nutrition, lifestyle-related diseases, and ethical food choices—within the science content. This integration promotes relevance, encourages critical thinking, and aligns with 21st-century learning goals that emphasize contextualized, inquiry-based education.

The alignment with curriculum competencies and the clarity of learning objectives both received favorable evaluations (2,67), indicating that the module is tightly connected to the Department of Education's K to 12 science curriculum and clearly defines its instructional targets. This ensures that teachers can seamlessly incorporate the module into their regular lesson planning while addressing mandated learning outcomes.

Furthermore, the organization of content and instructional activities were deemed logical, coherent, and engaging. Experts noted that the lesson structure supports progressive learning, with clear transitions from

conceptual input to guided practice and independent application. Visual tools, case studies, and group tasks were found to be particularly effective in supporting socio-scientific reasoning and student-centered learning.

Lastly, the module's assessment tools were evaluated as appropriate and well-constructed. Formative and summative tasks were aligned with the lesson content and learning goals, allowing for valid measurement of both conceptual understanding and socio-scientific decision-making.

DISCUSSION

Socio-scientific issue (SSI)-based learning in teaching the digestive system offers an effective framework to integrate core biological concepts with real-world health concerns. This study substantiates the effectiveness of this approach through both the needs assessment and expert evaluation of the developed module. Teachers recognized that linking digestion to socio-scientific contexts—such as obesity, dietary habits, and food ethics—enhances relevance and promotes student engagement. These findings align with Dewi et al., who demonstrated that SSI-oriented teaching materials significantly improve students' scientific literacy by connecting science content with meaningful social contexts, particularly in health education.[22] As shown in table 5, the participants consistently emphasized that framing digestion within issues of nutrition and lifestyle makes the topic more relatable and applicable to students' lives, which, according to Dewi, facilitates deeper conceptual understanding and enhances awareness of personal and public health.

Beyond increasing engagement, this study revealed that SSI-based modules enhance critical thinking, as previously reported by Sulistiani et al.[23] Teachers observed that students engaged more thoughtfully with lesson content when presented with real-life dilemmas related to food choices and digestive health. This aligns with the broader international literature which suggests that SSI instruction fosters skills in argumentation, ethical reasoning, and decision-making—core competencies in contemporary science education.[12,14] For instance, Sagmeister et al. found that role-playing activities around issues such as antibiotic resistance cultivated students' ability to evaluate conflicting viewpoints and propose balanced solutions, reinforcing the importance of integrating real-world debates in science classrooms.

Amdayani et al. also found that SSI-based modules significantly improved students' science literacy and understanding of health-related topics, a finding mirrored in this study where teachers rated the module as "Very Satisfactory" across most dimensions, including its ability to support independent learning and promote inquiry.[24] Similarly, Husniyyah et al. emphasized the power of problem-based learning when infused with SSI, which helps learners better grasp abstract scientific content such as digestion by applying knowledge to daily life decisions.[25] This is reflected in the feedback from participants who reported that students became more motivated and thoughtful when challenged to analyze personal food habits and their physiological consequences. The inclusion of scaffolding techniques in the module—highlighted by Erman et al. as essential in developing students' socio-scientific reasoning—further enabled learners to navigate complex discussions involving digestive processes, food regulation, and health risks.[26]

However, while the SSI approach demonstrated substantial promise, this study also revealed notable implementation challenges.[27] A key barrier identified was the limited familiarity of some teachers with SSI-based strategies, as shown in table 5. This lack of training and conceptual clarity hindered their ability to design and deliver lessons that effectively embedded socioscientific contexts. This mirrors the findings of Ngwenya and Mavuru, who noted that teachers often struggle with applying SSI approaches without professional development or localized exemplars.[28] Similar concerns were raised in studies by Huang and He, who emphasized that even preservice teachers benefit from co-design and mentoring structures when integrating SSI instruction in complex topics like human physiology.

Moreover, while Fadha et al. stressed that SSI instruction fosters students' ethical and moral engagement with issues such as nutrition, this study found that persistent conceptual difficulties—particularly in visualizing internal biological processes—can undermine the full potential of such modules if not addressed concurrently with proper instructional aids.[20] As detailed in table 2, students' misconceptions (e.g., believing digestion only occurs in the stomach) and inability to visualize enzyme action and nutrient absorption remain substantial hurdles. This highlights a critical tension: while SSI can motivate students and contextualize content, it does not automatically resolve deep-rooted conceptual misunderstandings. Addressing these limitations requires the simultaneous deployment of accurate visualizations, simulations, and step-by-step instructional tools—strategies echoed in the work of Çakmak and Bulunuz, who demonstrated that formative assessment and visual scaffolds were effective in supporting comprehension of digestive physiology in middle school students.

CONCLUSIONS

The development of a contextualized socio-scientific issues (SSI)-based module on the digestive system effectively addressed key instructional challenges by integrating real-life contexts with core biological concepts. Grounded in the first three phases of the 4D Model, the module was shaped by teacher-identified needs and validated by expert reviewers. The results affirm that SSI-based instruction enhances relevance,

supports critical thinking, and deepens scientific understanding. With a "Very Satisfactory" overall evaluation, the module shows strong potential for classroom implementation, pending further testing and refinement.

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CONFLICT OF INTEREST

The authors declare no conflict of interest related to the content or publication of this research.

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