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DOI: https://dx.doi.org/10.17352/raeeo

Review Article

Integrated Science and Health Education: Empowering Youth to promote their "well-being" through Problem-based Learning

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Received: 26 February, 2025
Accepted: 17 March, 2025
Published: 18 March, 2025

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Keywords: Science education; Health education; Self-regulation; Meta-cognition; Problem-based learning

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Abstract

Developing students' understanding of prevalent health issues that may significantly impact their academic achievement and social development is crucial to empower them in addressing these challenges and promoting their well-being. The Problem-based Learning (PBL) approach serves as an effective pedagogy to this end. Drawing on socio-constructivist and self-regulation concepts, this paper focuses on the transformative potential of interdisciplinary PBL activities that can facilitate students' learning and engagement with health issues in their science courses.

Introduction

Today's youth are confronting myriad health issues that significantly impact their well-being, their academic performance, and their social interactions in educational settings. Developing students' understanding of the prevalent health issues that could potentially impact their intellectual and social development is crucial to empower them in dealing with these issues. Thus, it is essential to develop stimulating and caring learning environments where they can develop an in-depth understanding of complex health issues, such as addiction, mental health, and physical health. At the same time, they need to learn how to cope with them to promote their well-being effectively [1,2].

This paper deals with these issues in the context of K-12 education to engage, educate, and, empower youth to critically consider the impact of prevalent and pervasive health challenges in order to be proactive agents for their well-being. First, we discuss the importance of developing learner-centered environments focusing on social connectedness and collaboration informed by socioconstructivism. Then, we share the potential of teaching health literacy through science education. Next, we examine the ways, in which problem-based learning approaches could be employed to integrate health and science education to engage youth in authentic, relevant, and meaningful problem-solving experiences. Subsequently, we consider how interdisciplinary problem-based learning can cultivate students' self-regulatory skills and practices. Finally, we propose an integrated pedagogical framework to achieve these objectives.

This study analyzed various bodies of relevant literature. To this end, scholarly works related to the salient themes discussed in this article were identified, reviewed, and synthesized to examine the pertinent findings, arguments, and recommendations. Key terms such as socioconstructivism, problem-based learning, self-regulation, health literacy, health education, and science education were used in different combinations to search the literature available in databases available through our university library and its collections. Additionally, related studies in Google Scholar were identified. A thematic analysis was conducted, drawing on key concepts related to this work. During this process, patterns of prevalent

Citation: Asghar A, MacIntosh N. Integrated Science and Health Education: Empowering Youth to promote their "well-being" through Problem-based Learning. Recent Adv Evol Educ Outreach. 2025;2(1): 012-018. Available from: https://dx.doi.org/10.17352/raeeo.000005

trends and similarities were examined across studies on each theme discussed in this article (socioconstructivist learning theory, integrated science and health education, problem-based learning to integrate science and health education, and self-regulation). Furthermore, we drew on key insights from this literature and our practice as science educators and researchers to develop an interdisciplinary pedagogical framework to promote health literacy and self-regulation through problem-based learning in science teaching.

Socioconstructivist learning theory

Socioconstructivist theory provides a useful framework for this teaching and learning process. "Socioconstructivism" is a student-centered learning theory grounded in subjective epistemology that acknowledges social interactions as key to the construction of knowledge within cultural settings, then internalized by individuals resulting in learner growth" [3]. As such, socioconstructivism places social relatedness and collaboration at the heart of the learning process. In other words, learning is intimately tied to and is shaped by one's social relations [4,5].

Socioconstructivism has substantially altered the traditional conceptualizations of pedagogy and learning. The pedagogical practices shaped by socioconstructivism focus on developing an awareness of students' prior knowledge and experiences, supporting them in developing a "shared understanding" of their learning objectives, encouraging them to question their existing understandings, and helping them become aware of their "own understandings and learning processes," thereby promoting metacognition [3]. Through these processes, learners develop, expand, modify, interpret, and negotiate their meaning-making through collaborative discursive practices, making informed decisions based on the evidence and findings of their investigations [6,7].

Furthermore, enacting a "democratic learning community" is central to socioconstructivist pedagogy. In this framework, students' voices and experiences are valued as they engage with contentious issues, empowering them to take on responsibilities related to health and ecological concerns in their schools and communities [8]. Most notably, students develop an expanded and informed understanding of their positionality in the world, their connection with their communities, and their role as responsible members of society [3,9-12].

As noted earlier, socioconstructivist learning environments engage learners in constructing shared meanings in their academic and social communities, where they collaboratively develop and apply new knowledge to solve complex real-world problems. This process motivates and empowers students to establish connections among different concepts, helping them develop a coherent understanding of their investigations. Cooperative and collegial inquiries lead students to build deeper, meaningful, and nuanced understandings of the world [8,13-15]. At the same time, they develop the requisite skills and capacities to address those problems by applying their knowledge to real-world contexts within their communities [8,16].

Integrated health and science education

Developing creative connections between science and health science education is critical to enhancing students' understanding of the scientific basis of prevalent health-related issues and how they may affect youth. To this end, science teachers can integrate health-related concepts into their science curriculum. At the same time, health science experts can provide important input in this process as students engage with authentic health-related problems in science courses [17,18].

Health-related behaviours developed during the early years can profoundly impact one's health in adulthood. For instance, substance abuse, eating disorders, and various forms of addiction can lead to enduring consequences. As such, schools significantly shape students' learning, growth, and physical, mental, and emotional well-being. Healthy students tend to perform better academically [19,20].

To this purpose, K-12 education can be crucial in addressing these issues to enhance students' health literacy and positively impact their health status and academic achievement [20,21]. In this regard, supporting students in developing the requisite knowledge, skills, and abilities needed to make informed decisions is a preeminent responsibility of schools [22].

Health literacy is "the degree to which individuals have the capacity to obtain, process, and understand basic health information and services needed to make appropriate health decisions" [22,23].

Health education is broad in scope and offers students the opportunity to ask questions about prevalent health problems and actively explore their answers [24]. Effective health education entails inspiring students to learn about health issues and actively introspect and transform their perspectives. This process involves students reflecting on their prior understandings and then re-constructing them in light of the observations and evidence obtained during health-related investigations [25,26].

Using problem-based learning to integrate health and science education

The Problem-based Learning (PBL) approach is a useful pedagogy to teach science and health education through an interdisciplinary perspective. This pedagogy could be used to educate students about key health problems, the factors that cause them, and ways to prevent and/or cope with them. Problem-based Learning (PBL) was initially developed to support medical students in collecting, acquiring, and applying knowledge to solve medical problems [27]. Subsequently, it has been embraced by health, dental, business, and education programs worldwide [28]. Research suggests that students who experience and participate in PBL find learning more connected to their lives and, thus, more engaging [29,30]. As such, PBL has been used effectively in K-16 settings to facilitate student engagement in inquiry-based learning through questioning, investigations, discussions, and proposing explanations for the evidence obtained [31-33].

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Notably, problem-based learning (PBL) serves as an effective tool for integrating the STEM (science, technology, engineering, and mathematics) disciplines with health sciences. Students begin to see how ideas, concepts, and skills from different disciplines interact and help them comprehend and solve authentic problems through creative approaches.

The PBL process is driven by a messy, open-ended problem that may have more than one solution. It helps make learning personally relevant and promotes student engagement in science, enabling them to make connections between school science and their everyday experiences. It also motivates them to consider future careers in science [34]. A study with high school students reported that science activities encouraging students to draw connections between their lives and science learning increased their interest in science and their course grades [35].

The PBL approach views learners as "stakeholders in a problem situation," engages them in "holistic" problems, and fosters an in-depth understanding of scientific concepts. In this process, "teachers coach students' thinking and guide their inquiry" to support learning. Since instruction and learning are organized around problems in this approach, developing well-designed problems is a key component of a curriculum incorporating PBL pedagogy. Teachers can develop authentic problems by drawing on curriculum standards and content, local media, or consultations with community members [36].

In addition to investigating an issue deeply, students use the knowledge gained through "complex and practical ways" to devise creative and plausible solutions. Problems requiring multiple solutions can expand students' original and innovative thinking. This approach also helps develop students' reasoning and persuasive argumentation skills to justify and defend their solutions. Furthermore, the PBL approach can excite gifted students by involving them in challenging real-world problems [29,37]. As well, PBL experiences can motivate students to keep themselves informed about prevalent health issues and inspire them to examine their own health choices based on this information critically.

Purposeful learning through collective inquiry and reflective thinking in teams about critical contemporary health issues fosters collaborative meaning-making, transforms existing understandings of these issues, and promotes holistic personal growth [25,29,38].

Vygotsky's concept of the Zone of Proximal Development (ZPD) aptly captures this learning process. The concept of ZPD is central to socioconstructivism. It is defined as "the distance between the actual developmental level (of the learner) as determined by independent problem solving and the level of potential development as determined through problem-solving under adult guidance, or in collaboration with more capable peers" [39,40]. Teachers facilitate collaborative problem-solving among students, motivating them to support each other in their learning and skill development [39,41]. The goal is to provide scaffolded support based on student's learning needs and encourage them to carry out the tasks independently.

As such, Problem-based Learning (PBL) pedagogies actively engage students in addressing socio-scientific and health-related problems through collaborative work. By engaging in complex investigations of critical issues that impact their personal lives and communities, sharing, debating, defending, and validating their arguments, students in the PBL process learn to make informed choices and decisions about themselves and society at large [3]. Not only can students from marginalized communities benefit from these learning experiences, but all students can confront critical health inequalities [19].

Students plan and conduct systematic inquiries to develop practical solutions to the problems they are investigating [42,43]. They assess their existing knowledge of a particular complex problem and identify the relevant information they need to learn in order to solve it creatively. This collaborative work mirrors how professionals in a field study solve real-life problems [41].

PBL challenges the traditional role and authority of the teacher, as the teacher assumes a fundamentally different role in this learning model. There is no direct transmission of information to students through lectures and demonstrations only. Instead, the teacher carefully selects a problem and facilitates students' questions, discussions, and potential solutions through their inquiries [44]. However, it is important to acknowledge the challenges teachers face when developing problem-based learning units. The impediments include teachers' internal resistance, inadequate professional preparation, lack of clarity about the concept and process of PBL, limited experience with interdisciplinary pedagogical and technological skills, time limitations in the curriculum, and discomfort with subjects beyond teachers' disciplinary expertise [45-47].

At its core, problem-based learning involves an authentic problem, group exploration, identification of prior knowledge, formulation of questions that need to be explored to find a solution, development of an action plan to answer these questions, collection of relevant knowledge by consulting relevant sources (both online and printed), and, if possible, talking to experts. Students then evaluate the information to identify and propose the "best" solution. Each group shares its solution and explains its reasoning to justify it. The solutions proposed by various groups are compared to evaluate their plausibility and effectiveness (Table 1). Additionally, PBL lends itself to authentic, performance-based assessment [10,36,48].

Practical problems promote curiosity, motivation, discovery, interdisciplinary exploration, active participation, collaborative learning, critical and creative thinking, acquisition and retention of new ideas, and a desire for learning [44,36,49]. Studies on using PBL indicate that this approach advanced student understanding, resulted in durable knowledge retention, fostered cooperative inquiry, increased attendance, and promoted self-directed student engagement in learning tasks [10,50,51].

Most importantly, PBL can be very beneficial in developing students' self-regulation, especially when they engage with

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health issues that necessitate changes in unproductive health behaviours and habits. Below, we discuss ways in which PBL can incorporate self-regulated learning practices.

Problem-based learning and self-regulation

Maes and Gebhardt (2000) define self-regulation as "a sequence of actions and/or steering processes intended to attain a personal goal. In other words, self-regulation consists of the individual's attempt to control his or her own behavior over time and across contexts to achieve self chosen goals" (p. 345) [52].

Self-regulatory practices include "goal-setting, self-monitoring, and self-evaluation" [24]. Essentially, self-regulation skills guide learners to deeply explore their knowledge, strengths, and shortcomings about their learning tasks. Importantly, they learn how to guide their thinking, develop their capacities for self-directed learning, and enhance their agency through self-reflection and "self-discovery." In other words, they take charge of their learning as "agents of their thinking," making meaning of their lives by using multiple reasoning approaches. At the same time, self-regulation skills can help students manage academic difficulties, anxiety issues, and interpersonal relationships [8,9,16,24,53-59].

These self-regulatory practices could be integrated into health and science education to make students' learning relevant, meaningful, and effective [24]. Thus, introducing students to self-regulation within the context of health and science education while addressing issues such as addictive behaviours and mental health challenges would enable them to set concrete goals and develop effective coping mechanisms (Figure 1). These goal-directed learning processes and self-regulation capacities may foster "health-promoting behaviours" in youth as they carry out a critical self-examination of their existing health choices [52,53,60,61].

It is worth noting that self-regulation is shaped by learners' beliefs about themselves and their emotional reactions, including doubts and fears, in specific performance contexts [59,62]. Therefore, students' agentic actions and resilience in self-regulated learning can help address their performance anxieties [24,52]. Adaptive health behaviours can be cultivated through scaffolded learning experiences, with guidance from teachers and peers within the ZPD. For instance, students can collaborate to identify target health behaviours and develop realistic strategies to achieve those goals by replacing detrimental health habits with health-promoting choices and habits [52].

Below, we share an example of an interdisciplinary PBL health intervention unit. The purpose of this PBL unit is to present concrete strategies to support students' learning about the addiction problem in their science classes, to engage students in making informed decisions and choices regarding their well-being, and to support their sense of agency (Table 1).

Conclusion

This piece aims to support science teachers in developing and enacting meaningful and timely problem-based learning units that integrate health and science education in their classes. Figure 1 encapsulates the framework that combines the concepts of self-regulated learning, problem-based learning, and health and science education with the goal of health-promoting behaviours. It is important to acknowledge that teachers face many constraints in creating and delivering relevant topics for engaging science education. To this end, the example presented in Table 1 can be used as a pedagogical resource in the classroom.

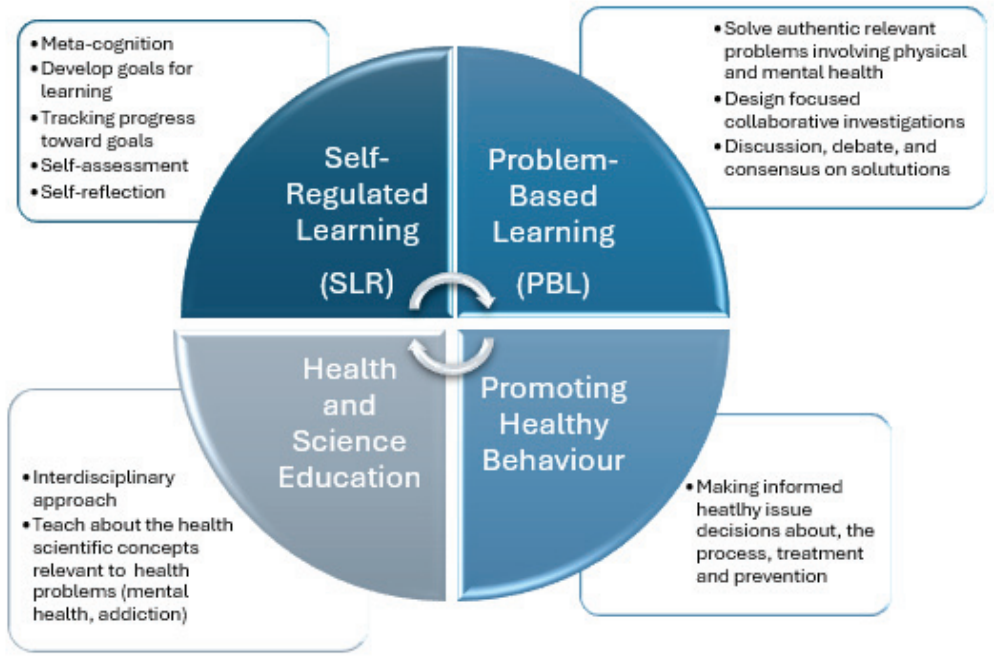

Figure 1: A Discursive Model for Self-Regulatory Practices to Promote Healthy Life Choices.

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Table 1: Example: Addiction - The Cell Phone

Problem: ***How does a healthcare team address the needs of an individual with cell phone addiction?***
• In this PBL activity, students, in small groups, discuss this problem to understand it from multiple perspectives.
• The teacher creates student groups based on their varying skill levels.
• They discuss what they know about this problem. They figure out what they need to know to solve this problem, including definitions of terms like addiction and mental health.
• Respectfully listening to each other in each team, the group records their collective understanding of the problem in their journals.
• Students share their understandings of the situation openly and respectfully.
• The teacher shares relevant resources from various sources (books and online) to support students in their research, as required.
• The teacher gives a presentation on the key science concepts related to addiction. The mechanisms involved. How does it affect the brain? How does it impact behaviour? What mental health issues are implicated? What are possible symptoms, triggers, treatment, and the underlying psychology?
• The teacher instructs students on best practices of self-regulated learning.
• The teacher develops a rubric to assess the quality and progress of this work and the effectiveness of the teamwork in consultation with the students.
• Students set up concrete goals to work on this problem. They outline a plan, individual tasks, and a timeline to achieve their goals, which is shared with the teacher.
• Students carry out their investigations.
• Students are encouraged to consult the teacher if they need research or pacing guidance.
• Students record their understandings of the situation and process and their perceptions of the other points of view in their journals, which will be shared with the teacher for commentary.
• The group work on planning, analysis, and communication allows students to connect as they self-delegate the tasks.
• Students continually keep track of their progress, using the rubric as a guideline.
• Students present their possible solutions (treatment plans to other groups and receive feedback from the teacher and their peers parenthesis.
• Students are encouraged to present their final report based on the feedback in creative ways (podcasts, videocasts, blogs) to communicate their findings to other youth in the school and their communities.
• The teacher and students evaluate their final report/product based on the class rubric.
• Students write three journal entries to self-reflect on their work and their learnings. How does this experience inform their engagement with cell phones, the internet, and social media?

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Citation: Asghar A, MacIntosh N. Integrated Science and Health Education: Empowering Youth to promote their "well-being" through Problem-based Learning. Recent Adv Evol Educ Outreach. 2025;2(1): 012-018. Available from: https://dx.doi.org/10.17352/raeeo.000005

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Citation: Asghar A, MacIntosh N. Integrated Science and Health Education: Empowering Youth to promote their "well-being" through Problem-based Learning. Recent Adv Evol Educ Outreach. 2025;2(1): 012-018. Available from: https://dx.doi.org/10.17352/raeeo.000005