



Integration of Sustainability Literacy in Digital Learning in Chemistry Education: A review

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Abstract

Giving students the knowledge and skills they need to support sustainable development is one way that sustainability literacy is being promoted. To enhance the material on sustainability literacy, this article maps perspectives on sustainability literacy and the relationship between the Education for Sustainable Development (ESD) idea and chemistry education. The study's objectives are to: (1) map out the body of research on sustainability literacy; and (2) examine how the ESD idea relates to chemistry education to promote sustainability literacy. According to Kitchenham, the approach is Review. 31 international journals published between 2012 and 2023 were the sources of the papers used; they were retrieved from the Google Scholar database and Scopus-indexed. The study's findings demonstrate the widespread applicability of sustainability literacy across a range of scientific domains and application foci. Many well-researched ESD implementation approaches in chemistry education might serve as a guide when creating ESD in the classroom. An overview of the content of sustainability literacy that is pertinent to chemistry education as well as how it may be applied to different learning domains is given in this paper. It also offers perspectives for scientists, chemical instructors, and ESD developers.

Keywords: education for sustainable development; chemistry education; sustainability literacy

Acknowledgments: We are grateful to everyone who helped make this research possible. I hope this research proves to be beneficial.

For citation:

Refmidawati & Megahati S, R. R.P. (2023). Integration of Sustainability Literacy in Digital Learning in Chemistry Education: A review. *Journal of Digital Learning and Distance Education*, 2(5), 625-629. <https://doi.org/10.56778/jdlde.v2i5.256>.

Introduction

Since the United Nations Educational, Scientific, and Cultural Organization (UNESCO) was established as an educational, scientific, and cultural organization, education has been at the center of UN activities. Through education, science, culture, communication, and information, UNESCO aims to promote intercultural understanding, sustainable development, peacebuilding, and eradication

of poverty. A sustainable future can be built through education (Holfelder, 2019) since it helps equip future generations with the necessary sustainable knowledge and skills and it can change people's attitudes and behaviors (Burbules et al., 2020). The Sustainable Development Goals (SDGs) on excellent education (United Nations, 2022) specifically underline the connection between education and sustainability. A dynamic learning approach is used in education for sustainable development (ESD), which motivates students to gain knowledge and abilities in this area (Sinakou et al., 2019); (Riess et al., 2022); (Laurie et al., 2016).

Encouraging and empowering students to modify their behavior and take action for sustainable development is necessary for integrating important sustainable development concerns into teaching and learning, as per UNESCO's definition of ESD (Pauw et al., 2015); (Saleem & Dare, 2023); (Boeve-de Pauw et al., 2022). According to the UN, it is imperative to include sustainable development principles in all facets of education and, in the end, to support behavioral changes in individuals (Mensah, 2019). ESD focuses on preparing youth to become responsible members of society in the future. Students need to be able to contribute to a democratic society and create a sustainable future for themselves (Parry & Metzger, 2023). According to what has been said, the significance of this literature review can be found in its ability to offer a methodical analysis of research mapping about sustainability literacy from 2012 to 2023 as well as a model of ESD implementation in chemistry education, which can serve as a guide for developing sustainability literacy content in chemistry education. The objectives of this study are to (1) map out the body of research on sustainability literacy; and (2) understand how the ESD idea relates to chemistry education to promote sustainability literacy.

Methodology

A Review method was applied in this investigation. Finding, assessing, and interpreting all relevant research for a certain research question, topic area, or phenomenon of interest is possible through the use of reviews, or SLRs. This approach serves a variety of functions, such as offering direction to researchers preparing for upcoming investigations, summarizing the body of research on a specific topic, weighing the pros and cons of various topics, and serving as a foundation for suggestions for interventions (like teaching large classes). provide a summary of the model associated with an implementation, regardless of size. Accordingly, this approach entails a thorough search to locate all pertinent published and unpublished works on a topic; a methodical integration of search results; and an evaluation of the quantity, kind, and caliber of evidence about certain research questions.

Results and Discussion

Charting Research Areas in Sustainability Education

Numerous implementations of research on sustainability literacy have taken place worldwide. Articles addressing sustainability literacy research themes are relatively uncommon at the national level. This is a research gap that should be filled to increase the treasures associated with sustainability literacy. This section covers sustainability literacy generally, including its use in several scientific domains and research areas. Research on sustainability literacy has been applied in several scientific domains, including the School of Design, School of Law, and School of Management, according to the analysis of 13 articles. In general, research has been conducted with the following goals in mind: 1) to analyze the impact of the sustainability literacy assessment tool known as sulfites (sustainability literacy test); 2) to create learning strategies that support sustainability literacy; 3) to create a model of sustainability curriculum; 4) to investigate learners' perspectives and knowledge regarding sustainable development and sustainability literacy; and 5) to create the Sustainability Research Symposium (SRS) to promote sustainability literacy. For clarity, Table 1 presents the different elements that were chosen for this investigation.

Tests, learning methods, curriculum, and learning materials related to sustainability have all been studied as means of fostering sustainability literacy. A multiple-choice, questionnaire or true/false exam may be used to assess sustainability literacy. This serves as an example of how to include sustainability literacy in lessons in the classroom. Numerous research studies have demonstrated the need to foster sustainability literacy among individuals. People who understand the value of sustainability literacy are essential to building a sustainable future (Chen et al., 2022). A person with sustainability literacy possesses the information, values, attitudes, and abilities necessary to solve challenges and create sustainable living (Diamond & Irwin, 2013; Winter & Cotton, 2012). Curriculum designers, for instance, might incorporate sustainability literacy into their courses or create learning modules with a sustainability theme to expose it to students during the curriculum-designing process (Brandt et al., 2021); (Cavalcanti-Bandos et al., 2021).

The relationship between ESD ideas and chemistry education

The goal of this section's discussion is to familiarize readers with the fundamental ideas required to advance their sustainability literacy. In the realm of chemistry education, more focus is made on the connections between ESD ideas to create pertinent content for sustainability literacy. Education for sustainable development and sustainable development are two of the principles that make up the foundation of sustainability literacy. One of the main tenets of Agenda 21 is education for sustainable development (Grosseck et al., 2019). Education is positioned to prepare students to be able to comprehend and manage sustainability concerns by developing and teaching future leaders (Alm et al., 2022); (Müller et al., 2020). Green chemistry knowledge can be included in sustainability literacy curricula in chemistry education to address sustainability challenges that are pertinent to chemistry, according to the findings of a review of eighteen papers covering topics such as green chemistry, chemistry education, and ESD. As a result, chemistry education should provide students with a better understanding of chemistry's place in society and enhance their capacity to assess a range of chemistry-related issues, including how chemistry can help create a sustainable society, shape the future, and manage natural resources (Pernaa et al., 2022).

Furthermore, several academics created models for integrating environmental science and development (ESD) into chemistry education (Herranen et al., 2021). These models examined how green chemistry may help achieve sustainable development objectives, including bringing up pesticide and plastic issues to enhance ESD instruction in chemistry classes. To varied degrees, chemistry can assist in achieving all of the Sustainable Development Goals (SDGs), according to (Axon & James, 2018); (Kobayashi & Nakajima, 2021). Chemistry is particularly important for (i) developing clean and sustainable energy sources, such as environmentally friendly fuel cells and efficient solar energy use; (ii) applying green chemistry principles and processes to the production of chemicals; and (iii) creating new analytical methods required for more efficient environmental monitoring. As a result, chemistry plays a significant role in ensuring that the SDGs are met to create a sustainable future. In the realm of chemistry education, the idea of green chemistry can serve as the primary subject for sustainability literacy instruction based on the topics that have been covered. Sustainability literacy in chemistry education is characterized by the benefits of green chemistry in addressing sustainability concerns.

Conclusion

This paper examines the broad research trends on sustainable literacy. This study demonstrates how crucial it is to incorporate sustainability literacy into a variety of subject areas to create people who can support sustainable development. Developing sustainability literacy focuses on several learning components. The relationship between ESD concepts and chemistry education—in this case, how the green chemistry method may address sustainability concerns—is how the integration of sustainability literacy in chemistry education is expressed. This work may serve as a

guide for future researchers creating sustainability literacy materials tailored to the field of chemistry education, particularly concerning sustainability concerns associated with chemical subjects.

Conflicts of Interest

No conflicts of interest are disclosed by the writers.

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