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Environmental education and digital solutions: An analysis of the Lebanese context's existing and possible digital actions

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One of the main purposes of environmental education is to tackle the youth belief system and raise specific concerns linked to ecology and sustainability. Nonetheless, the educational approach to ecological concerns is partly about the methods used to reach effective results. The advancement of technologies and the rapid spread of social media have accelerated the use of online means of communication. While technology and digital tools have proven effective for educational purposes, it becomes necessary to examine the relationship between technology and environmental education, particularly in the Lebanese context. This position paper provides a review of studies on education, the environment, and digital tools, more specifically, studies conducted in Lebanon. It particularly focuses on the engagement of educational institutions and social incentives to raise environmental awareness and develop ecological behaviors in Lebanon. The results of this study will help stakeholders and researchers for future implementation of digital solutions in the Lebanese context toward a greener agenda.

KEYWORDS

environmental education, digital solutions, social influence, online platforms, technology

Introduction

The gravity of environmental complications calls for creative solutions to strengthen environmental awareness strategies. Environmental education, as described by [Breton \(2018\)](#), is not only limited to achieving eco-actions but also extends to provoking a will to achieve them. He hypothesizes that environmental literacy, and particularly related attitudes and values, does not rely on an easy process of dissemination. He proposes digital educational approaches for a deeper understanding of environmental justice and the adoption of scientific critical thinking regarding environmentally problematic topics. According to [Bennett \(2008\)](#), digital strategies are necessary, particularly when addressing the younger generation. Educational

and creative processes shall sweep the youth's lifestyle communication modes such as digital influential solutions (Bennett, 2008).

Ever since digital practices evolved at a rapid pace, the processing awareness methods shall follow state-of-the-art plans, both in formal and informal learning contexts. As an example, mobile phone applications can improve the learning experience through interactions that are not limited to schooling education (Wallace and Bodzin, 2017). Online platforms have proven to be an alternative mode of communication and have shown a great impact on users' values and actions (Jones et al., 2012). The continuous spread of media platforms and social software assists in the construction and circulation of ideas as it helps raising common concerns (Bennett, 2008). While online platforms demonstrate influential proficiencies, Brereton (2018) has studied the outcome of using YouTube[®] and gaming applications on the uptake of environmental values and environment-friendly behaviors. For example, he found that contents with filmed formats have a large impact on the audience's perception of the environment. Hence, the initiation of an ecological aspect in young people's identities depends on the influential processes of the action plan. In low and middle-income countries (LMIC), the situation and the awareness strategies are crucial due to the intrinsic challenges of their socioeconomic and political contexts. Taking into consideration the Lebanese context as a developing country with intense socioeconomic difficulties (Ghosn-Chelala, 2019), it can be assumed that influential strategies, such as modern communicative models that bump into youth's interests, are needed to intensify the citizens' ecological concerns and environmental awareness.

The first section of this research addressed digital aptitude in the social change process. It examined the ability to raise awareness toward certain topics through digital assets. This helped to identify whether altering a lifestyle and raising environmental concerns can be positively impacted when addressed through offline and online technology.

The second section aimed at describing offline digital settings in Lebanese educational institutions. It helped to identify the current situation in Lebanon in terms of actual technological facilities and circumstances, such as the financial situation, the educational institution's mission and vision, and the political support for the educational digital intake in schools.

The third section aimed at identifying the integration of online digital solutions into Lebanese educational strategies. The Lebanese institutions' educational approaches were investigated to describe the situation. This section also examined the determination of the educational teams to integrate and master the use of online solutions within their teaching process. The analysis in this section was also done based on the challenges of the Lebanese context in terms of a developing country, such as technical difficulties, political weaknesses, and socioeconomic difficulties.

The fourth section addressed the environmental awareness action plans undertaken in Lebanon. The efficacy of strategies was analyzed by focusing on the dynamics of building new environmental values in comparison with the integration of technology. This section inspected the teaching and learning techniques and the engagement of educational institutions in environmental social work.

The fifth and final section discussed the overall studies that are used to address the previous sections in terms of research design methodology, sample sizes, theoretical framework used, and studied variables. The goal of this section was to evaluate the scientific literature tackling the issue of environmental and sustainable education in the Lebanese context and to offer an overview of its current limits. The conclusion was based on these results.

Empirical research on environmental and sustainable education and awareness conducted in the Lebanese context is limited and is an emerging topic. This position paper provides a review of environmental education and digital solutions in Lebanon. It aims at providing a list of significant features to be taken into consideration in future environmental awareness plans. In addition, this study investigates the possible implementation of effective strategies for environmental education in the Lebanese context, highlighting the obstacles encountered. The findings of this study help to identify levers and barriers for the implementation of digital solutions for environmental education. The urgent need to perceive this problem as a national emergency requires implementing state-of-the-art plans based on studies of the various influencing factors spotted, to be adapted in the Lebanese context. The conclusion of this position paper represent a starting point for environmentalists and educational stakeholders concerned with enhancing environmental education in Lebanon.

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Digital strategies in the social change process

The goal of this section is to explore the possible impacts of online social networks on the younger population and to examine the communication strategies that have proven to be useful while addressing environmental issues. According to Brereton (2018), the educational digital format options vary to include offline and online solutions. The list of technological practices varies and extends from technological tools for classroom use to the use of mobile phones online platforms or applications. Online learning settings can enhance the learning experience through interactions that are not limited to schooling education (Wallace and Bodzin, 2017). Online platforms have proven to be an alternative communication mode and have

proved major impacts on the users' personal choices and decisions (Jones et al., 2012). To demonstrate the influence of online social platforms, Goulet-Lanthier (2018) conducted a campaign via Twitter and Instagram in his research to study the impact of social media on users' opinions. The researcher has deduced an extensive influential scheme that accompanies the conversion of personal opinions. It consists of first addressing the targeted problem in professional content. In addition, it is supposed to be created by a qualified popular influencer or an opinion leader who understands the givens, estimates the impacts, and contributes to finding convenient solutions. There are numerous studies in this field. For instance, the effects of an online campaign to raise awareness on the COVID-19 pandemic were studied by Wahbeh et al. (2020). They found that social media platforms help configure significant knowledge when shared by professionals. In other words, the useful aspect of knowledge shared online tended to manifest only when scientific details were shared, such as the symptoms, the testing, and the recommendations around the pandemic topic.

Social networks could impact users' awareness and political concerns, independently of any guidelines from the government (Bennett, 2008). Moreover, the digital process of seeking information, discussions, and participation in campaigns was demonstrated to alter a pattern of behaviors (Koc-Michalska et al., 2016). According to this study, the fast rhythm of innovations has created a range of modern online platforms where peer-to-peer interactivity is facilitated through discussions. Such social digital debates are accentuated in forums where users share common interests and seek collaboration and connectivity. Among the conclusion of this study, and regarding the online interventions to raise users' civic engagement particularly, a positive impact has been demonstrated for the contribution of social media to the citizens' engagement with civic and political life.

In research on the impact of technology on citizens and netizens of society, modern digital incentives were proposed to be reached throughout the academic context (Achmad, 2021). He showed the possibility but also the importance of integrating the digital solution into the learning process due to the combination of artistic factors and knowledge. He explained that the various forms of digital academic integration do not limit the impact on the student's scientific knowledge but exceed it to alter their social interaction (Nurmandi et al., 2015; Sahay, 2015; Shao, 2021, as cited in Achmad, 2021). According to the author, the sociological impact of online digital integration in schools, represents a framework for the non-material culture of a group. Consequently, changes in the implemented technology formats procure changes in the way people think, as it also sways the way they relate to others' opinions and concerns.

Brereton (2018) examined in his study the impact and the best practices of the use of fictional films and documentaries, as well as the use of YouTube, video games, and other social platforms that address explicitly or implicitly environmental issues. Modern online platforms are

distinguished by the interactivity they provide to the users. According to the same study, this represents an engaging process that initiates autonomous personal influences and changes. According to Brereton (2018), the combination of YouTube and environmental literacy is effective when providing professional material and potential alongside the awareness-raising process of personal concerns raised around environmental issues. An example of music videos related to environmental issues was provided in this study as it initiates a psychological impact due to the audiovisual factor complementing the textual narration. Another media format that Brereton examined in his research is documentaries. For instance, food documentaries or eco-documentaries can be an incentive for a large audience to adjust their diet toward forms of sustainable consumption instead of industrialized food products.

Livingstone (2011) examined the policy elements in the use of digital solutions for environmental literacy. This study examined the correlation between the learning process and civic engagement. The researcher's conclusion included a combination of two effective elements during the academic digital integration: the participatory self-expressive opportunity for students and the engagement of the educators to incorporate online activities. In this sense, the media exceed the domain of leisure and entertainment to become infrastructural for users' personal lives and impact their public as well as their private lives. The author concludes by recommending that academic stakeholders, the media industry, and civic society shall be involved in the implemented strategies. In the Lebanese context, Temsah and Moukarzel (2018) found that, in addition to the previously mentioned stakeholders, in a strategy to implement digital tools for environmental education, parents shall also be brought to play a major role to determine the student's needs and interests accurately and plan the strategies accordingly.

Offline digital settings in the educational Lebanese strategies

The Lebanese context displays a shortage of institutional equipment but also a lack of governmental support in integrating digital tools and the environment into education in general (Hamzeh et al., 2019). Neither financial support nor drafted laws have been presented by the Lebanese Ministry of Higher Education to preserve the quality of the technology solutions implemented in the institutions (Mekhael and Karamah, 2018). Hence, offline digital solutions could be a key element in response (Slay et al., 2008) to the implementation of environmental awareness educational strategies.

Nonetheless, many private schools have recognized the impact of technology in the educational process and established individual initiatives to integrate technological tools such as active boards and video games from the schools' budgets (Yehya et al., 2018). However, this integration was devoted to supporting the official curriculum only and not the

informal aspect of learning, such as endorsing students' values, personalities, or behaviors (Temsah and Moukarzel, 2018). Interestingly, the findings in the study of Temsah and Moukarzel confirm that technology had a positive impact on reasoning and critical-thinking skills among school students in academic subjects. Furthermore, Nicolas (2018a) study was conducted in private Lebanese schools since they are capable to integrate modern educational methodologies without the administrative and bureaucratic restrictions and financial limits of the public sector. Of 119 students, 62% reported using computers/tablets either almost every day or one or two times a week during class hours. The findings of this study revealed that despite a weak correlation between the use of technology in school and the development of citizenship values, there is a relationship between the student's attitude toward technology itself and their global citizenship attitude. While it was noted that the technological tools adopted were limited to the use of interactive whiteboards, PowerPoint® presentations, Microsoft Word® documents, or internet resources, the studied sample wished for a variety of tools such as YouTube®, social networking websites, and online forums to be used during class time.

Rabih Baalbaki, the co-founder of the MENA EdTech Alliance (a global company dedicated to improving education, mainly in helping accelerate the digital transformation), president of the Lebanese Association for IT Professionals, and president of the Advanced Computer Technology Center (ACTC), shared the recent number of collaborations with Lebanese schools (Awada and Baalbaki, 2020). Baalbaki stated that currently 1,145 private schools and 513 public schools in Lebanon are equipped with educational technology tools. The equipment varies depending on the budgets of the schools. This technology plan by the ministry of education and higher education classified the digital tools with respect to the financial level of schools into four tiers. In the low-budget tier, the technology integration in schools has been limited to the provision of computers and projectors, knowing that the internet connection is only planned but not available, as mentioned in the report. Nonetheless, Awada and Baalbaki (2020) confirmed that the educational teams have accomplished training on the use of the equipped tools at all levels and are provided with extensive educational resources.

The integration of online digital solutions in the environmental education strategies in Lebanon

The intense engagement of the youth in online networks provides a powerful potential in terms of decision-making and personal choices (Bennett, 2008). A study conducted in Lebanon showed that communication on sustainable development goals has been continuously advancing but needs

more standardization on the online digital level (Oueiss, 2021). The ecological online resources, as mentioned in the study, are intended to be used by community members but also by stakeholders responsible for environmental awareness. The researcher elaborates and states that monitoring and evaluating the process of strategies are obligatory to establish a manner of trust for the information.

Regarding the trending online platforms and applications, the algorithm strategy plays a major role, enhancing the users' views and engagement with the online content of the same topic as it intensifies related content for the same user (Huang et al., 2021). According to Ghosn-Chelala (2019), Lebanon, as an LMIC, struggles in sustaining meaningful engagements in the digital sector in public schools due to economic difficulties, especially since the situation is worsened by a currency crisis (Bitar, 2021). In general, financial difficulties are a major challenge for the Lebanese context. A dearth of collaboration with informal environmental initiatives has been reported due to budgetary issues (Traboulsi, 2019). Ghosn-Chelala (2019) also pointed out that civics curriculums are deprived of information and communication technology among this study's survey results; 11 out of 17 sample public schools have confirmed no access to the Internet. In this sample study, none of the schools' principals was implementing any environmental awareness plans or activities, although a few have agreed to incorporate environmental clubs within their institutions. The clubs were restricted to providing environmental knowledge but did not involve practical activities or technological tools. The educators stated they would not implement extra practices as long as their timings were not located in the academic annual program, even if they were personally aware and concerned for the environment. In other words, the schools' policies play a radical effective role only when understanding and approving an agenda implementation actively with continuous supervision and follow-up, without any disregard for the related expenses. The digital learning approach might be a potential suggestion for future action plans and educational policies that would improve online teaching in current educational systems. In contrast, the school environment should be more careful to equip the school administration, teachers, and students with soft skills and strategies for online teaching. These study results revealed major activators for effective educational change, which encourages the rethinking of school budgets and educational approaches as they enable applicable dimensions of online teaching. Such an implementation would necessitate policy changes to be incorporated into the Lebanese schools' system to improve the learning outcomes and curricula goals throughout the online teaching methodology. The learning environment has to be adapted accordingly to improve the learners' digital experience in different grade levels. This transformation can be effectively achieved in parallel with teachers' training to implement innovative technology solutions for authentic goals such as personal student development.

In another recent research about the challenges faced in distance learning in Lebanon during the COVID-19 pandemic, questions were raised about the factors that affected online teaching (Mouchantaf, 2020): 60% of the teachers' sample mentioned technical complications such as Internet issues or dysfunctional platforms; 50% of the sample stated low confidence in the procedure's transparency and integrity; and 30% declared they needed more training and/or institutional support. The lack of equipment, such as hardware or Wi-Fi, was also reported to affect sessions. Conversely, only 10% of the sample did not encounter major issues with online teaching. The Internet problems, the equipment's deficiency, the lack of training, the preparation time, and the curriculum duration are all factors that can have a negative impact on online or digital solutions for sustainable and environmental education. Nicolas (2018b) has conducted research in Lebanon to study the impact of technology on the development of students' citizenship attitudes in high schools. The author has documented a challenging factor in the technology integration in Lebanese schools: Lebanon is among the worst ranked countries globally regarding Internet speed and affordability. This rank was considered in progression with respect to a few earlier years, given that in 2018, the Ministry of Telecommunications and Ogero confirmed an increase in Internet service speed (Maharat Foundation, 2018). The OOKLA international broadband speed test metric indicates a slight progression: Lebanon has reached the 127th rank after it was 174th. In terms of the reasons, this problem was associated in the report with an incomplete infrastructure and the absence of a clear policy for the Ministry of Telecommunications. The low-speed problem remained up to 2020, as revealed by Khzam and Lemoine (2021), and designated in the research as an essential variable to be taken into consideration in Lebanon.

Another study was conducted in the same context of online teaching during the COVID-19 pandemic and aimed at studying the teachers' attitudes toward the use of online platforms (Farah and Frayha, 2021). Interestingly, the results indicated a high sense of teachers' self-efficacy with online teaching, despite the lack of previous implementation and training for online platforms in educational practices. In spite of the teachers' preference to interact in a face-to-face setting, it was reported that private school teachers were able to engage all the students in the learning process. In addition, they stated their willingness to proceed with technological solutions when needed. Furthermore, Lebanese teachers' perception of digital communication should be taken into consideration: according to Farah and Frayha (2021), the acceptance and ability to engage students in online classes was related to the positive quality of time spent on the platforms. This equipment deficiency problem tends to become less of a concern in some private schools, which are generally trustworthy in the Lebanese communities, unlike many other countries (Nakhoul and Perry, 2019). The interrogations remain crucial in these reliable institutions where

educators do not take advantage sufficiently of those online resources and social media enough. The agenda plans shall be designed having regard, not only to teaching material in class but also the interactive extra-school communication. The potential of social media as resources and tools for educators is neither invested properly nor mentioned in any action plan accessible for the teachers in Lebanon (Pruneau et al., 2010). The digital solutions' diversity extends rapidly and includes online social media platforms, interactive websites and communities, online short documentaries, etc. However, it is necessary to take into consideration the specifics of the context: information about climate change is mostly inaccessible in Lebanon due to a lack of Lebanese and regional media interest in environmental issues (Naoufal, 2014). In contrast, the Lebanese teachers displayed an acceptance of the use of technology despite the lack of training during the COVID-19 pandemic (Farah and Frayha, 2021). In addition, they declared creating a positive environment for their virtual classes and engaging all the students in the learning process. It was also reported that they feel efficient in integrating digital solutions in the future when needed. The analysis of these perspectives leads to the following three assumptions about integrating information technologies in Lebanese school contexts for environmental education. (1) Lebanese teachers are open to technological integration in their academic programs, either inside or beyond the classroom walls. (2) An agreement among Lebanese teachers that environmental issues are not valued enough in the education curriculum and actual school practices. (3) Financial difficulties are an obstacle to the implementation of technological solutions.

The environmental awareness action plans in Lebanon

In the formal educational context, the pedagogical team's qualifications for educating about ecological awareness shall be taken into consideration, especially when dealing with such a complex and abstract phenomenon (Pruneau et al., 2010). In Lebanon, teachers are considered by institutional stakeholders as people "in charge of teaching": they must apply the curriculum, omitting their part in the decision-making and neglecting their involvement in the development of educational policies (Diab et al., 2014). As such, environmental education and awareness become an additional obligation, independent of teachers' own professional development and needs (Diab et al., 2014).

Nonetheless, this issue cannot be understood and tackled independently of the main Lebanese context: the role given to educational institutions, the resources provided to the public sector, political conditions, and the official curriculum. Each of the mentioned factors is crucial for social change; thanks to environmental education and the development of eco-citizenship in Lebanon (Reaidi, 2015). More precisely,

after the Lebanese Civil War (1975–1990), the Lebanese state “has been able to accomplish little in the way of (re)building public services, controlling development, or dealing with environmental problems in any consistent or centralized fashion” (Nagel and Staeheli, 2016, p. 252). Hence, this void has been filled by “a resurgent civil society consisting of NGOs” (Nagel and Staeheli, 2016, p. 252) working toward a greener agenda. Additionally, the participants in Naoufal’s (2014) study identified “an obstacle to climate change education specific to Lebanese and other contexts characterized by political tensions and security incidents” (p. 287). In fact, in such a context, “the public does not perceive it as vital, not only because it is a global phenomenon whose manifestations are not yet visible but also because of the local situation” (Naoufal, 2014, p. 287).

There have been few attempts to hypothesize and derive conclusion on the possible factors influencing environmental education in the Lebanese context. One of the studies aimed to examine the environmental awareness responses among Lebanese students. The results showed that environmental awareness is higher in public schools than in private ones (Diab et al., 2014). However, most of the interviewed teachers have mentioned a link between the student’s ecological culture and the family education. They referred the lack of eco-citizen lifestyle to gaps in the ongoing process of educating family members. They also declared that time and/or program constraints in schools represent obstacles for implementing ecological movements and environmental awareness plans. According to the study, the reason behind this result was the implementation of extra-curriculum activities. However, no measures were taken to examine students’ personal ecological values and lifestyles, and no integration of information technologies was found.

Few local organizations took the initiative to help schools getting involved effectively in the environmental problems. For example, the Lebanese Organization for Green Schools (LOGS) started collaborating with schools since 2015 (Traboulsi, 2019). It aims at engaging students in ecological solutions and triggering their mentality toward an autonomous environmental responsibility. They proposed plans that do not only include practices for students but also for teachers to help them master the integration of the environmental theme among their academic subjects. Therefore, they presented an environmental glossary that can be introduced in language, mathematics, and science classes. For example, they advise teachers to familiarize the students with the “virtual water” concept during their lesson’s explanation, which is the needed amount of water to produce an item they use. In addition to that, the organization offered to coordinate with the institutions to establish environmental clubs and put the students in charge to run them and decide on the activities they want to happen. The action programs involved applicable activities aspects, such as planting trees and cleaning up campaigns, but also integrated technology to endorse watching environmental documentaries. These efforts did reach a limited response: only 38 schools

agreed to collaborate. The negative responses were made due to budgetary issues and resource limitations (Traboulsi, 2019). LOGS states that it takes only 1 year for the school to become eco-friendly; the problem remains at its financial level, but not in its will, despite the rewards they are expected to receive from the environmental consultancy firm, E-EcoSolutions. Traboulsi, the founder of LOGS, states that the target is to achieve changes in the behaviors and recognize the alternative eco-solutions, but she reveals a hampering aspect in the Lebanese culture, where citizens fail to react to issues unless they reach a grave stage.

Another study examined environmental clubs’ programs in 20 Lebanese schools (Mekhael and Karameh, 2018). The results showed that the impact of the environmental clubs was restricted to students’ cognitive environmental knowledge but not to their practical eco-friendly behaviors. In other words, the clubs were concerned with educating the environment but did not incite an awareness attitude accordingly. There was a gap between the theoretical and practical frameworks, which is decisive for a connection between human practices and values (Bonnett, 2002, cited in Mekhael and Karameh, 2018). The study compared international, regional, and Lebanese school-based programs. The international programs have been implementing several approaches, including training, involving all students actively; measuring the effectiveness of media to spread the word about citizens’ environmental actions; and channeling students toward sustainable behaviors. The regional schools were reported to be implementing fewer strategies. Regarding the Lebanese school-based programs, the study reported no official agenda registered by the institution or the Ministry of Education. Moreover, the initiatives originated from national or international programs. The positive response reached a limited number of schools: only 23 Lebanese private and public educational institutions have agreed to incorporate the program of inter-curriculum activities. Another initiative was incorporated with a total positive response from 91 Lebanese schools, universities, and organizations. This initiative is aimed at minimizing solid waste disposal and diverting the waste stream away from landfills. However, it tackles four aspects of the participants’ identities: according to Mekhael and Karameh (2018), it develops skills for environmental sustainability, thus students can become active and responsible toward their community. In the list of environmental initiatives, the same study reported the actions of the Associated Schools Project Network (ASPnet). Despite the launching of the programs in 1994, 66 schools were collaborating in 2018. The activities implemented were concerned with peace and human rights understanding. In addition, an annual conference of Lebanese Catholic schools took the initiative, in 2016, to launch environmental clubs in schools. The target was to spread the word about environmental concerns. Its program has been set according to international standards to enhance environmental knowledge and skills.

The comparison between the international or regional initiatives and the Lebanese incorporated plans showed a

lack of development for the institutions' members to educate on environmental topics and use innovative technologies. In addition, there was a lack of activity integration, especially the digital online and offline involvement. The principals of 17% of schools reported having financial challenges to implement activities in their environmental club. The rest of the sample mentioned struggling with logistics procedures with municipalities and ministries that hampered the activities, especially at the community level. Otherwise, regarding the lack of training, the school principals who collaborated with a non-governmental organization (NGO) reported coordination between the NGO and the teachers, but only in the framework of helping them integrate the environmental theme in their teaching subjects.

Among the literature review of this position paper, the movement for Green Schools was the only action plan supported by the Ministry of Education and Higher Education, the Ministry of Environment, and the Global Coalition of Green Schools in Lebanon. Their program aimed at developing a green aspect in the citizens' identities. The number of positive responses from schools was higher than the previously mentioned initiatives. A total of 100 public and private schools incorporated the program's sustainability solutions listed in the following categories: recycling, green spaces, energy efficiency, water efficiency, health and safety, and education for sustainability.

Discussion: The theoretical frameworks and methodologies for studying digital solutions, education, and the environment in Lebanon

As the literature review showed, when integrating technology into Lebanese schools, multidimensional factors interfere, such as the school's vision and mission, the educators' attitude, the technological infrastructure, the curriculum review, and the educational team's professional development.

This theoretical framework has been adopted by scholars in their studies in the Lebanese context. [Temsah and Moukarzel \(2018\)](#) conducted research to study the effect of technology implementation on students' reasoning and communication skills. They considered that social and cognitive variables are critical to determining the success track while implementing digital action plans in schools. They focused on the importance of managing discussions that incite students' critical thinking. Therefore, their study was based on Bloom's taxonomy levels while accentuating the higher-order thinking skills requirements from educators to use instructional strategies that stimulate working memory. In other words, educators should enhance students' skills to relate acquired knowledge to new ones ([Krathwohl, 2002](#); [Hughes, 2014](#); [Bou Jaoude, 2018](#), as cited

in [Temsah and Moukarzel, 2018](#)). [Johnson \(2010\)](#) researched the use of the Internet and child development to validate the efficacy of an ecological techno-subsystem when carefully implemented. He has highlighted that the interrelation of the advanced mode of online communication has a positive impact on the development of higher-order thinking skills such as the application and evaluation of data. Regarding the students' skills, [Temsah and Moukarzel's \(2018\)](#) study was also linked to students' problem-solving aptitudes. This ability to make decisions and act autonomously without guidance is defined by Vygotsky as the zone of proximal development (ZPD) ([Bruner, 1984](#)). The ongoing learning using technology was perceived in [Temsah and Moukarzel's](#) study through the lens of social constructivism. This combined framework background brought to light a situated learning approach ([Lave and Wenger, 1991](#)).

In their research on information technology adoption and implementation in higher education in Lebanon, [Tarhini et al. \(2019\)](#) used a theoretical framework based on socio-constructivism alongside an ecological paradigm. They established their study on the social-ecological model (SEM), proposed by [Bronfenbrenner \(1979\)](#). According to this theory, the selective perceptions of individuals are consequences of various knowledge and experiences acquired from the surrounding environment. In this sense, an individual chooses to consider a problem or ignore it based on what they observe or what they want to observe ([Christensen, 2016](#)). The principles of SEM can be complementary to [Bandura's \(2006\)](#) social cognitive theory since social change can be triggered by a change in behaviors ([Schunk, 2012](#)). SEM combines the effects of cognitive, behavioristic, and emotional variables. In this model, individuals' behaviors are not only affected by their own knowledge and practices but also by others' actions. Social change is therefore reflected in individual, interpersonal, and public interaction.

The main learning outcome of an efficient environmental education program is to develop eco-citizenship and foster autonomous and self-regulated strategies toward social change. According to [Bandura \(2006\)](#), collective engagements accelerate the mutual influences affected by social learning. [Tarhini et al. \(2019\)](#) highlight the importance of the social environment for individual behaviors toward social change.

In his study about environmental awareness, [Brereton \(2018\)](#) relies upon the theoretical framework of [Kellner's \(2003\)](#) media culture, focusing on the interconnections between media and society. The media culture theory is a combination of several focusing points derived from the multi-perspective cultural studies as follows: (1) culture's norms and values that criticize the manuscripts of media content and the outcomes; (2) the culture's values that the media project adopts, defends, valorizes, and aims at spreading. Regarding the outcome targeted, [Kellner \(2003\)](#) has highlighted the importance of media literacy studies, media production, the audience's interpretation of the digital content, and the interaction between the audience members. Due to being part of an audience, actual social relationships

TABLE 1 Review on studies conducted in the Lebanese context about education, environment, and digital solutions.

Quantitative research methodology				
References (<i>n</i> = 3)	Variables of the study	Sample size	Collection data tools	Theoretical framework
Awada and Baalbaki, 2020	The educational institutions' digital learning available techniques.	- 600 students - 130educators	Survey	N/A
Maharat Foundation, 2018	Governmental and private internet access.	- 300 Lebanese centers	Reports	N/A
Mekhael and Karameh, 2018	Students' behavior toward sustainable development. Impact of school type, gender, and environmental clubs on students' skills of sustainable development.	- 437 school students	Surveys	N/A
Qualitative research methodology				
References (<i>n</i> = 7)	Variables of the study	Sample size	Collection data tools	Theoretical framework
Farah and Frayha, 2021	Educators' perceptions toward the online teaching.	- 31 educators	Survey	N/A
Ghosn-Chelala, 2019	Students' internet usage	- 17 school principals - 340 students	Survey	N/A
Hamzeh et al., 2019	The technology adaptation's efficacy in the higher education institution.	- 435 universities' members	Survey	N/A
Khzam and Lemoine, 2021	Technology's Social Influence. Attitude toward internet consumption.	- 9 internet consumers - 5 e-commerce experts	Interviews	Diffusion of innovations' theory (Rogers, 2003)
Mouchantaf, 2020	Impact of teachers' perceptions of online teaching on students.	- 300 educators	Surveys	N/A
Oueiss, 2021	Impact of social media on users' trust attitude. Impact of users' involvement on the reputation and collaboration of the stakeholders' goals.	- Not identified (members of a digital company)	Surveys	Framing theory (Entman, 1993)
Yehya et al., 2018	Obstacles of the implementation of ICT in the Lebanese secondary physics classes.	- 94 secondary schools	Surveys	N/A
Mixed method research design				
References (<i>n</i> = 4)	Variables of the study	Sample size	Collection data tools	Theoretical framework
Nicolas, 2018b	Impact of technology integration in school on students' global citizenship attitudes.	- 119 students	Surveys and focus group interviews	The network society theory (Castells, 2010)
Reaidi, 2015	Ecological Engagement level.	- 762 students	Surveys and interviews	N/A
Tarhini et al., 2019	The cultural and political effect on the implementation of technology in universities. The impact of partial integration vs. complete integration of IT. The research studies the effect of budgetary issues on the IT integration.	- 300 university instructors - 150 staff members	Surveys and interviews	The social ecological model (Bronfenbrenner, 1999)
Temsah and Moukarzel, 2018	Teachers' practices <i>vis-à-vis</i> the integration of technology Impact of technology integration on students' reasoning and communication skills in science.	- 164 students - 3 administrators - 4 teachers	Observations, surveys and interviews	The cognitive development theory (Vygotsky, 1978)

will result. Notably, this process defines an audience agency mechanism as described by Webster (Brereton, 2018). This agency is manifested in the public empowerment movements promoting specific or general ideas.

Table 1 sums up the methodologies used in the studies conducted in the Lebanese context about education, environment, and digital solutions. The studies are grouped into categories of quantitative research methodologies, qualitative research methodologies, and studies implying mixed methods within their qualitative research design. The variables of the studies, the samples' sizes, and the collection data tools are displayed.

As observed, only 14 studies tackle the subject of environmental education and/or eco-citizenship involving digital solutions in Lebanon. They range from 2015 to 2021. Out of 14 studies, 6 use surveys from small (i.e., $N = 31$ educators as in Farah and Frayha, 2021) to large sample sizes (i.e., $N = 762$ students as in Reaidi, 2015). In contrast, the collection data tools were appropriate for the analysis of the variables, although there was limited research variety on eco-citizenship education in the Lebanese context. Further empirical research respecting survey standards is highly needed to better understand the variables at play in environmental education in Lebanon.

Moreover, only five out of fourteen studies use a theoretical framework for their empirical research. More specifically, the only three quantitative studies using surveys do not integrate a theoretical framework for their questionnaire building. Therefore, it can be argued that the variables studied, such as behavior toward sustainable development (as in Mekhael and Karameh, 2018), are not integrated into a larger theoretical model and only constitute an observational study about sustainability education. Overall, the three quantitative studies are observational or descriptive studies of environmental education in Lebanon.

The seven qualitative studies do not differ greatly: only two of them integrate a theoretical framework for the construction of the research design. Oueiss (2021) used the framing theory of Entman (1993) to study the impact of social media on the trust attitudes of users and the impact of the involvement of users on the reputation and collaboration of the stakeholders' goals in Lebanon. Khzam and Lemoine (2021) used the diffusion of innovations theory (Rogers, 2003) to study technology's social influence and attitude toward Internet consumption in the Lebanese context.

The last four studies use a mixed-method research design. Only one of them does not use a theoretical framework (Reaidi, 2015). Tarhini et al. (2019) used the SEM (Bronfenbrenner, 1999) to study the cultural and political effects of the implementation of technology in universities, the impact of partial integration vs. complete integration of IT, and the effects of funding on IT integration in Lebanon. Nicolas (2018b) used the network society theory (Castells, 2010) to study the impact of technology integration in school on students' global citizenship attitudes in Lebanon. Finally, Temsah and Moukarzel (2018)

used Vygotsky's cognitive development theory to study Lebanese teachers' practices *vis-à-vis* the integration of technology and the impact of technology integration on Lebanese students' reasoning and communication skills in science.

The literature review of this study shows that the use of a theoretical framework is limited. Only five studies involve a theoretical model to build the data collection tools and analysis: two are qualitative and three use a mixed-method research design (mostly surveys and interviews).

Conclusion

This study examined studies on the impact of offline and online technology on the beliefs and behavior of citizens, more specifically in the Lebanese context. An overview of the use of technologies to disseminate ecological content and its impact on the lifestyle of the youth of Lebanese was also provided. The setting of an agenda aims to take advantage of the motivational digital material in the classrooms. However, it also aims to benefit from interactive extra-academic online communication. In particular, the digital assets and the social media platforms can help influence the values of young students if implemented according to a professional agenda planning with supervision, using professional content, and addressed through the modern online platform. The literature review on the environmental awareness plans implemented in Lebanon revealed that digital solutions are neither properly implemented nor are they included in any action plan accessible to educators.

The research conducted in the Lebanese context shows that the use of technology is affected by the budget limits of educational institutions. Financial difficulties are a major challenge for Lebanese institutions in general. The lack of governmental financial support hinders technology uptake. According to Nakhoul and Perry (2019), and in addition to the numbers presented in the study by Awada and Baalbaki (2020), private schools are more prone than public schools for integrating the use of technology within their educational strategies, thanks to slightly better budgetary readiness, although the technological tools integrated are restricted in some institutions to the use of computers, projectors, or active boards. Thus, the use of online solutions is more likely to be absent in educational institutions on a large scale. This conclusion was confirmed by the study of Ghosn-Chelala (2019). Subsequently, educators find it difficult to engage in simple school activities, such as online calculation of the students' footprint or displaying an online documentary about ecological issues. Based on the research of Mouchantaf (2020), during the COVID-19 pandemic when there was a crucial need for digital learning, the educational teams in several private schools reported various technical major problems. These issues may lead to the limited time to be technically prepared for an urgent situation.

Based on the results of the study conducted by Ghosn-Chelala (2019), the principals and coordinators of the schools display a vulnerable understanding of environmental practical concepts. Therefore, while the decision-makers of the Lebanese institutions are not estimating the gravity of the situation, their academic programs do not integrate environmental concerns.

The digital solutions mentioned in this study are not limited to a certain category. Their diversity extends rapidly in modern times and includes online social media platforms, interactive websites, clubs and games, documentaries, and music videos. In contrast, Lebanese teachers have demonstrated an acceptance of the use of technology despite the lack of training during the COVID-19 pandemic (Farah and Frayha, 2021). They also reported creating a positive environment for their virtual classes and engaging all the students in the learning process. It was also reported that they are efficient at integrating digital solutions in the future when needed. Accordingly, Lebanese teachers are hospitable to technological integration in their academic programs, either inside or beyond the classroom walls. However, the absence of an implemented digital use in Lebanese institutions leads to a hypothesis that relies on the ideology of low valorization for environmental issues and considers that the avoidance of technology solutions is due to the belief that environmental conditions are not highly crucial. However, empirical research on the ecological values of the Lebanese educational teams is still very limited.

As observed, NGOs consider themselves reaching out to the population at large. Hitherto, they tend in practice to cultivate relatively low engagement in participant numbers, who become well-versed in international norms, while excluding or alienating broad segments of the population (Mekhael and Karameh, 2018). It is therefore indistinct whether the environmental purposes are sufficient incentive generators for desired behavioral transformations, or if they just provide an institutional and ideological framework robust enough to reshape collective identity and social practices. One must keep in mind the specifics of a given context, and as such, adopt a situated approach to deal with complex issues, such as environmental, sustainable, and eco-citizenship education. In fact, “people exposed to war tend to develop a persistent short-term mode of reasoning exclusively focused on survival needs; they find it difficult to be more concerned about the environment, especially as armed conflict is often followed by a period of high political, social, and economic instability and a lack of safety” (Naoufal, 2014, p. 287).

Unfortunately, many of the studied articles in our review suffer from a lack of methodological rigor such as the use of standardized data collection tools (previously validated psychometric scales) or a theoretical model encompassing the studied variables as a structured framework. Thus, there is still a need for robust empirical studies (quantitative, qualitative, or mixed method) in the Lebanese context for studying the environmental education situation among the local population

and educational institutions, with the integration of digital solutions. For instance, the “Environmental Citizenship Questionnaire” (ECQ) developed by Hadjichambis and Paraskeva-Hadjichambi (2020) could be applied in the Lebanese context, specifically among Lebanese youth (school and university students). Another example is the “Teacher beliefs of environmental education questionnaire” (TBEDQ) created and validated by Mullens and Cater (2019), which could be used among Lebanese teachers.

This review helps to describe the Lebanese situation regarding the use of digital tools in environmental education plans. There is less empirical research on environmental and sustainability education and awareness in Lebanon, which is a significant limitation. This study aims to lay the groundwork for future environmental awareness strategies in Lebanon. It should also help scholars in planning future empirical research on environmental education and digital tools in Lebanon.

Author contributions

MK and RC carried out the research. MK wrote the main parts of the manuscript under the supervision of RC. RC participated in the writing of the discussion and conclusion. SG supervised the final versioning of the manuscript during the whole reviewing process, also verified scientific and language adequacy, and rewrote some parts. All authors contributed to the article and approved the submitted version.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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