

Proposed Concept of Green Thinking in the Curriculum of Sciences in Elementary School

المفهوم المقترح للتفكير الأخضر في منهج العلوم بالمرحلة الابتدائية

Nihad Mahmoud Kasnawi

نهاد محمود كسناوي

Associate Professor of Science Curricula and Teaching Methods, Education, Umm Al-Qura University, Makkah, Kingdom of Saudi Arabia.

أستاذ مشارك، قسم مناهج وطرق تدريس العلوم، كلية التربية، جامعة أم القرى، مكة المكرمة، المملكة العربية السعودية.

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الملخص:

تحتاج الممارسات التعليمية في المملكة العربية السعودية إلى تعزيز الاستدامة والابتكار في مناهجها، بدءًا من المراحل التعليمية الأولى، من التعليم الابتدائي إلى التعليم العالي. هدفت الدراسة إلى اقتراح منهج مبتكر جديد للتفكير الأخضر ضمن مناهج العلوم في المدارس الابتدائية السعودية. علاوة على ذلك، توصي هذه المراجعة بعدة مبادرات لمنهج قائم على التفكير الأخضر يمكن دمجها لتعزيز الفهم البيئي لدى طلاب المرحلة الابتدائية. استخدم الباحث المنهج التحليلي الوصفي من خلال توظيف التحليل الموضوعي لتقييم المناهج الحالية لتعليم العلوم عبر مناطق مختلفة من العالم. كما استندت هذه المراجعة إلى بيانات جمعت من مصادر تعليمية محلية متعددة في المملكة العربية السعودية، مثل المدارس والكليات وقطاع التعليم العالي، والتي تقوم حاليًا بدمج مفهوم التفكير الأخضر في مناهجها. وقد استجابت رؤية السعودية ٢٠٣٠ أيضًا للحاجة إلى إصلاحات تعليمية مبتكرة لتعزيز الوعي البيئي لدى طلاب العلوم. يسهم الإطار المبتكر المقترح للتفكير الأخضر بشكل كبير في تنمية مهارات التفكير النقدي لدى الطلاب، وتحسين مستوياتهم الأكاديمية، وتعزيز مهارات التعلم التعاوني، وتقوية ارتباطهم بالطبيعة، وتمكينهم من تجاوز العوائق التقليدية والثقافية، من خلال إحداث تحول رائد نحو الاستدامة والابتكار. كما تم تضمين النتائج المحتملة لدراسات أخرى من خلال تحليل معمق لعدد من المقالات البحثية، ومواقع إلكترونية دولية، ومصادر عالمية موثوقة، بهدف جمع البيانات ذات الصلة لتحقيق أهداف البحث. وتوصي الدراسة بشكل واضح بأن اعتماد التفكير الأخضر في مناهج العلوم يسهم في تنمية مهارات التعلم لدى الطلاب بشكل عام، مثل المهارات النقدية والإبداعية والتحليلية، مما يعزز لديهم توجهًا استباقيًا نحو الوعي البيئي والاستدامة.

الكلمات المفتاحية: المدارس الابتدائية، منهج العلوم، التفكير الأخضر، المملكة العربية السعودية.

Abstract:

The educational practices of Saudia Arab need to foster sustainability and innovation in their curriculum, starting from the initial level of education, from elementary schooling to higher education. The study aimed to propose a new innovative curriculum for green thinking in the science curriculum for Saudi elementary schools. Furthermore, this review recommends several initiatives for a green thinking curriculum that can be integrated to enhance the environmental understanding of elementary school students. The researcher employed a descriptive analysis approach by using thematic analysis to evaluate the current curriculum of science education across different regions of the globe. Additionally, this review was based on the data gathered from different local educational resources of Saudia Arab, such as schools, colleges, and the higher education sector, which are currently integrating green thinking in their curriculum. The Saudi Vision 2030 also responded to the innovative need for educational reforms to promote environmental awareness among science students. The proposed innovative framework of green thinking significantly contributes to enhancing students' critical thinking skills, improving academic levels, collaborative learning skills, connection to nature, and empowerment towards traditional and cultural barriers by providing a pioneering shift towards sustainability and innovation. The potential findings of other studies were also included through an in-depth analysis of several research articles, an international website, and authentic international resources to gather the relevant data for the research to fulfill the research objectives. The research significantly recommended that the adoption of green thinking in the science curriculum enhances the overall learning skills of students, such as critical, creative, and analytical skills that empower a proactive attitude towards environmental awareness and sustainability.

Keywords: Elementary Schools, Curriculum of Science, Green thinking, Saudi Arabia.

Introduction

Green Thinking in the context of the elementary school curriculum is a modern term that refers to a sustainable and innovative type of education that serves to protect countries, communities, and societies from environmental hazards (Monte & Reis, 2021). According to Adnyana et al. (2023), the modern and innovative education context, which upgrades the educational needs of children according to environmentally friendly standards, is the major goal of green thinking in education. According to Kartel et al. (2023), it is the most basic right of children to get an education in a healthy and positive environment that has been conducted through the collaboration of teachers and parents to make their children good learners for their brighter future. Similarly, to inform children about the importance of sustainability and environmental protection at an early age for the sake of environmental benefits is also their right. The unequal distribution of sustainable practices and interventions became the reason for distraction and disturbance in the green environment. According to the report of the Arab Forum for Environment and Development (2019), the educational setting of Saudia Arab requires resources and materials to adhere to the concepts of sustainability and green thinking for the future generation to meet their sustainable developmental goals in education (Hassan, Gaber & El Sherbin, 2019).

In elementary science schools in Saudia Arab, green thinking plays a vital role in developing strong foundations among science students by enhancing their concept of environmental awareness (Shutaleva, 2023). At the elementary level, students were gradually introduced to basic phenomena observed in daily life surroundings, such as biodiversity, climate change, global warming, the production of waste, and the concept of renewable energy. However, the implementation process of these pedagogical practices and learning about green thinking requires a lot of expertise from teachers and instructors. The idea of creative teaching to engage elementary school science students is not an easy task. According to Singh et al. (2022), the improvement required in constructing a proficient generation that possesses high thinking skills and self-learning and leads towards sustainable development can only be achieved through green education. The major initiative to protect the environment has become one of the prominent goals for countries like Saudia Arab due to its direct impact on human lives. The Kingdom of Saudi Arabia introduced several plans and programs to initiate “Green thinking” in an educational context, but they are specially designed to be implemented in higher education institutions (Sharabi, 2023).

The spread of green culture is one of the essential goals in modern educational culture due to the emerging trends of sustainable development, with the integration of green thinking in various fields of life. Similarly, the role and responsibility of educational institutions in promoting green education are of great importance (Abo-Khalil, 2024). Several studies have emphasized the need for green thinking in the curriculum of educational institutions because it is the most basic

block from where innovation and sustainability can emerge (Ahmad et al., 2019; Sharabi, 2023; Mohammad et al., 2024). According to Ramli (2012), green school programs and initiatives are considered effective approaches for the promotion of desirable personal qualities among students to improve their knowledge, ethics, and various norms. Additionally, these programs seek to foster community services among the students and enhance their awareness regarding environmental protection. There is a necessity to coordinate with adequate entities of the Saudi Arabian education system who are willing to incorporate sustainable development goals to transform and resolve upcoming challenges regarding environmental awareness by integrating green thinking into the curriculum of elementary science schools (Essa & Harvey, 2022). According to TIMSS & PIRLS International Study Center (2019), the current authorized curriculum of science in Saudia Arab is based on a theory-based framework that only allows students to memorize new learning without practical implications. Due to this issue, students lack an understanding of the basic phenomena of daily life that are explained by scientific experiments, such as water evaporation, physical balance, air pollution experiments, a DIY compass, and water filtration. The above-discussed experiments helped students build their understanding regarding hands-on learning and benefited from these experiences. However, the students have been built up through the education and learning they received from elementary school settings in the developmental stages. However, the students at higher education in Saudi Arab universities faced several challenges because they did not possess expertise in hands-on learning by experimental approaches.

To bridge the gap that arises from the implementation of the current science curriculum at the elementary level in the educational context of Saudia Arab, especially in the science curriculum, researchers proposed an innovative framework for the integration of green thinking in elementary science students to shift the current curriculum of science in Saudia Arab schools. The study discussed and recommended impactful suggestions to empower the Saudi Arabian elementary science schools with green thinking initiatives to achieve sustainable developmental goals. The study conducted by Mohammad et al. (2024) pointed out that responsible authorities of educational institutions must launch innovative and sustainable national programs towards the incorporation of green thinking, which has the ability to transform the conventional education system. The study aims to conduct a descriptive analysis in the form of a thematic analysis based on different themes to elevate the importance of green thinking in the science curriculum, through an in-depth overview of different advanced and improved green curricula integrated in international regions like the United Kingdom, Switzerland, and Indonesia. The researcher has also proposed an innovative framework of green thinking to improve the environmental knowledge of students with practical implications. Furthermore, significant suggestions and recommendations regarding different factors, such as students’ awareness regarding green thinking, realistic problems of the environment, environmental hazards, renewable energy, and waste

management protocols. The proposed curriculum was established to seek the attention of the Saudi Arabian education system toward the exclusive implementation of green thinking in their elementary science schools.

Research Objectives

1. To explore the environmental knowledge of elementary school students by implementing proposed green thinking in the science curriculum of Saudia Arab.
2. To propose an innovative framework for green thinking in the science curriculum of elementary schools in Saudia Arab

Research Questions

3. How to explore the environmental knowledge of elementary school students by implementing proposed green thinking in the science curriculum of Saudia Arab.
4. What recommendations should be given for implementing proposed green thinking in the science curriculum of elementary schools in Saudia Arab?

Literature Review

Theoretical framework

The Pro-environmental behaviour (PEB) framework, represented by Steg et al. (2014), and the Flow Theory (FL) by Csikszentmihalyi (1990) significantly supported the research aim and objectives. However, the intervening relationship between green thinking and behaviours has been conceptualized through these theories. To bring theories and frameworks for the emergence of green thinking in education curricula or environmental awareness is one of the tasks for policymakers and stakeholders (Shutaleva, 2023). The awareness regarding the environmental hazards that destroy the green environment of the surroundings can only be achieved through the practical implications of real-life experiences and educational practices. Increasing the interest of young students in growing environmental problems and issues has been a profound need of the educational sector, with the assistance of experts and knowledgeable people (Sultan et al., 2020). In the same sense, the adoption of pro-environmental behaviour (PEB) or green behaviour initially arises from the values and perspectives of the citizens. PED emphasizes the control conditions of environmental protection, awareness, and well-civilized behaviours and attitudes towards positive and green change in order to shape environmental sustainability among the students of the elementary level (Varela-Candamio et al., 2017).

According to Boyes and Stanisstreet (2012), the establishment of pro-environmental habits among elementary school students to persuade them to reduce their waste production is essential for their strong character building as responsible citizens. Similarly, another theory named Flow Theory, represented by Csikszentmihalyi in 1975, is defined as the state in which the motivation level of people is immensely high, so that nothing else seems to matter to them due to their high commitment and motivation level towards these specific tasks and activities. The suggestion of flow theory emphasizes the integration of subjective experiences, personality, and desirable outcomes, translated by the level of motivation. In the context of

this study, FL theory plays a vital role in describing the importance of self-motivation and self-learning for the introduction of green thinking in Saudi Arabian education. According to Trevino & Webster (1992), the prevalence of FL in the field of education has the ability to derive high and effective results with positive attitudes. The conceptual framework of the study showed a robust theoretical foundation to support environmentally responsible behavior in elementary-level students. These two theories have provided sufficient justification for promoting a green thinking curriculum by engaging students in an advanced learning curriculum to foster sustainability and innovation among them.

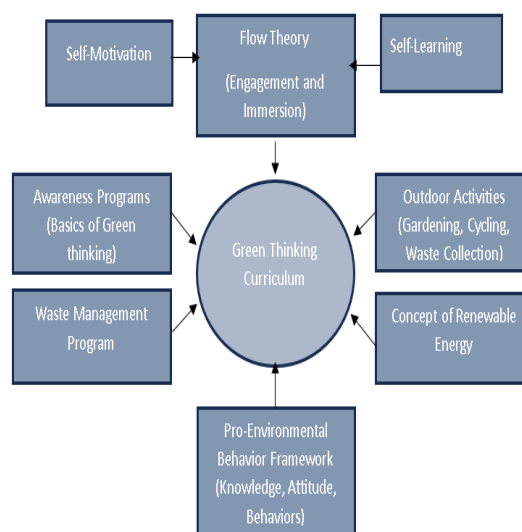


Figure 1 Conceptual Framework of Green Thinking Curriculum

Saudi Arabia's current science curriculum

The basic elementary school curriculum consists of Arabic, art, geography, and history, which is not clearly sufficient for students in the 21st century. The officially followed science curriculum in Saudi Arabian schools mainly focused on the text curriculum to position the students' learning process (Saudi National Curriculum Framework, 2018). The management of schools has planned several activities for students to provide a space to learn and grow while understanding new learning. However, the major focus is on the philosophy of science textbooks that emphasize the importance of scientific methods of investigation and practical implications of science experiments, such as scientific reading, writing, drawing, sampling collection, and other activities that increase their interest in the science curriculum.

According to TIMSS & PIRLS International Study Center (2019), the current science curriculum designed for fourth-grade students in primary years of school education included the following topics in science books: an understanding of living creatures, cells, classification, plants, animals (vertebrates and mollusks), and animal conservation. Additionally, environmental systems, Earth, water, minerals, Space and the solar system, Substances and their change, and Power and energy are the main topics that have been

taught to the science curriculum students. According to the report of The Economist conducted by Fadia Jiffry (2023), following the curriculum, which is heavily dependent on Arabic and Islamic learning, restricted students from gaining insightful knowledge of science and technology. The report also revealed that the expenditure of the Saudia Arab in gross domestic products on education is larger than in wealthy countries but still, students are not educated enough to pass to Trends in International Mathematics and Science Study (TIMSS), in the recent sets of standardized global math test under half of the Saudia Arab students scored lowest benchmark as compared to the students of other countries such as South Korea and England.

One of the schools in Riyadh actively participated in fostering sustainability to upgrade its existing education curriculum. The British International School Riyadh has been a member of Eco-schools since 2018 and has been majorly focusing on waste minimization, litter, energy savages, and global citizenship with respect to climate change. The school has followed the conceptual framework of the UN Sustainable Development Goals that underpinned the most significant sections of the units. It is a three-year project and has aligned its aims with the Saudi Arabian Vision 2030. However, inclusive of several programs and activities, the school has organized the BISR Recycling Centre and Precious Plastic workshop for students. The main focus of the workshop was to spread awareness among students regarding waste management and recycling of their own waste (British International School Riyadh, 2023).

Current Status of Green thinking in Elementary school education

However, the concept of environmental acknowledgment, especially in the field of education, is not a new curriculum, yet it is not completely implemented in the elementary schools of Saudia Arab. Instead, the traditional curriculum focuses on theory-based learning, which only allows students to recognize new learnings and lessons without practical implementation. There are a lot of universities that are promoting green entrepreneurship among their students by promoting the idea of environmental awareness and values within the incorporation of their academics. According to Yi (2021), the universities are providing effective training facilities to their students and teachers and emphasize getting adequate information about green energy, renewable energy, waste production, and recycling of waste. According to UNICEF (2024), the basic indicators for the incorporation of green transitions in science curriculum students mainly focused on their creativity level, communication, incorporation of ideas and concepts into real-world experiences, risk management, and decision-making. For this purpose, Vision 2030 is a pragmatic blueprint for employing a sustainable and green ecosystem within the country (Al-Zohbi & Pilotti, 2023). The Vision 2030 of Saudia Arab purports to advance sustainable developmental goals that promote diversity in all aspects of life, such as economics, education, and health.

Another example of a green thinking curriculum in the educational settings of Saudia Arab discussed in the case study research conducted by Al-Zohbi et al. (2023), in the context of Saudia Arab College, discussed the contradictions faced due to sustainability. The researchers found that college students were very aware of climate change, its sources, and potential remedies connected to it. However, another study conducted at Damman University noted that the students involved in the onsite campus practices were able to get real-time experiences but to foster exclusive environmental sustainability skills, the offered opportunities were fewer as they only focused on landscaping, jobs fairs, and waste recycling that is not enough for the university students (Abubakar et al., 2016).

Green Thinking Initiative in Saudi Arabian Education

According to the report of the Saudi Press Agency (2024), the Green Schools Initiative was recently started by King Abdullah University of Science and Technology (KAUST) to educate students about proper environmental preservation techniques and to increase environmental awareness in the schools in Thuwal, a Jeddah seaside community. Further information was also revealed in a report that, as part of the university's social responsibility programs, the initiative was started in partnership with the Ministry of Environment, the Jeddah Education Department of the Ministry of Education, the Saudi Investment Recycling Company (SIRC), Averda, Saudi Dow, and Napco. However, the school serves as a platform for combining the potential efforts of various relevant organizations to increase environmental awareness among students. Furthermore, students were encouraged to adopt strategies and educational practices that ensure environmental sustainability by reducing and recycling plastic and paper waste in Thuwal schools. The research conducted by Sharabi et al. (2023) in Saudia Arab stressed the implementation of awareness programs for promoting sustainability and innovation among the schooling-going students by providing specific courses, programs, and creative workshops to engage them.

International Curriculum of Green Thinking in Education

The international regions are increasingly emphasizing the implementation of green thinking curricula by recognizing the critical role of education and learning practices for sustainability in the environment (Taimur & Sattar, 2019). The study highlighted successful examples of green schools and green curricula adopted globally that promote inclusive engagement of students with nature. The United Nations established the Decade of Education for Sustainable Development (DESD) from 2005 to 2014, and also welcomed UNESCO on board for the integration of sustainability and development in all academic subjects. The effective approach they applied was a holistic inter- and trans-disciplinary approach that has a clear vision and value towards the ethical use of green thinking in the curriculum (UNESCO, 2005). Additionally, the main focus of these environmental educational programs is to transform the prerequisite teaching curriculum that

mainly focuses on the basic knowledge of fundamental courses such as General knowledge, English, basic mathematics, and science knowledge. Similarly, the evaluation of the green curriculum of one of the primary schools in the UK found that the green curriculum has the ability to equip students with extraordinary knowledge and skills that lead them towards educational success. The research conducted by Cho (2023) in the US highlighted that in the year 2021, at COP26 in Glasgow, the minister of education and environment protection recognized the immense gap in terms of lack of knowledge, skills, and positive attitudes in the transition towards climate change. Radhika Iyengar, director of the education sector at Columbia Climate School's Center for Sustainable Development, stated that the time has come to make climate education an essential requirement for the national curriculum in education. The aim is to incorporate it as a primary strategy for minimizing climate risk, energy transformation, and land and water protection.

Role of Green Thinking Curriculum in Saudi Arabian Elementary Science Schools

The development of green thinking in the curriculum has the ability to tailor the ordinary schooling system into an extensive body of knowledge for the sake of environmental safety and protection for sustainable development goals (Sharabi, 2023). Green thinking in the curriculum also fosters the developmental skills of students, which is considered one of the most emerging skills among students of the 21st century (Ahmad et al., 2019). However, the process of building a sustainable ecosystem requires reengineering procedures from the beginning, and similar fabrication is required for the Saudi Arab education system. Additionally, the development of a green thinking curriculum for science students promotes a sense of environmental awareness and protection through their academic and learning activities (Hadzigeorgiou & Skoumios, 2013). According to Hariram et al. (2023), the increment of urbanization and technology in the 21st century has already triggered the safety postulates of environmental safety and security. As a result of this dominance, many educational institutions have become more sterile and less attentive towards the production of waste. Therefore, the urge to introduce green or natural space in the school setting has become a more prominent need of society, especially for young students. According to Pirchio et al. (2021), the ethical values of green thinking in the curriculum have significantly contributed to students' physical, psychological, and educational settings. The green thinking curriculum sets high inspiration within the school environment, which creates a strong influence on student and teacher collaboration and interaction, allowing them to study and learn faster.

Future Initiatives of Saudia Arab for Green Thinking curriculum

According to the report of the Ministry of Education, Kingdom of Saudi Arabia. (2024), The Ministry of Saudia Arab aims to accomplish its vision for sustainable development in order to address the

demands of the present world without endangering the prospects of future generations to meet their needs for an ambitious future. However, attaining development enhances the standard of living, builds generations, and supports the economy without compromising the natural and environmental resources of the Kingdom. The Saudi Arabian Ministry aims to implement several programs and initiatives for the creation of a knowledgeable and sustainability-oriented society through a knowledge-centred economy. The number of programs listed in the Ministry of Education, Kingdom of Saudi Arabia. (2024), links to all developmental goals mainly occupied with digitalization and innovation, such as Electronic and distance learning, Saudi Digital Library, Open data for education, and Electronic societal participation. According to the Ministry of Education, Kingdom of Saudi Arabia. (2024), the Ministry of Saudia Arab has contributed to taking the new initiatives that are related to the sustainable development goals for the new university education system, and contemporary initiatives to support research in scientific and nonscientific contexts in university education. Additionally, early childhood education expansion identified interventions for gifted students and professional development of male and female teachers in Saudia Arab.

Methodology

This study utilised a descriptive analysis approach to generate themes by conducting an in-depth thematic analysis of previous literature and research articles, including Saudia Arab and international regions, to compare their curriculum plans. The researcher has employed descriptive analysis techniques to find patterns and themes to showcase the findings of this study with the help of previous literature that has not been evaluated yet (Loeb et al., 2017). The researcher employed a thematic analysis technique in order to discuss the findings of the study. One of the key advantages of using themes in the descriptive analysis is research flexibility and progress. It allows researchers to explore and compare new findings in a similar context of research, unlike any other method (Vaismoradi et al., 2016). It also allows the researcher to uncover nuanced perspectives of educators, learners, and other stakeholders toward the integration of green thinking in education. However, all the key features highlighted in the previous studies to describe the importance of a green thinking curriculum were discussed in the discussion study in the form of themes to align the results of the proposed curriculum.

The researcher evaluated several research articles, international reports, and websites to gather secondary data from multiple authentic resources. The incorporation of the international curriculum in green thinking reflects the most useful practices in education because developed countries such as the UK and the USA provide an established framework to the Saudi educational settings that particularly emphasizes green thinking skills, such as critical thinking, problem-solving, learning engagement, and awareness. Additionally, the validation of international curricula has been estimated by their improved results and student

outcomes. According to the results of the Trends in International Mathematics and Science Study (TIMSS), the students from England scored 88 percent, which is considered one of the highest benchmarks (Fadia Jiffry, 2023). However, green thinking strategies and curriculum plans implemented in other countries like the UK and the USA were deeply evaluated and compared to take guidelines and direction from their green thinking implications in schooling education. This study systematically observed the extensive details and characteristics of green thinking in the curriculum in elementary school students as research participants. To investigate the useful insights that need to be incorporated into the educational context of Saudi Arab schools, specifically for science students in elementary schools. Additionally, various amounts of data were collected through the green thinking curriculum followed in different countries, which directly helped the researcher represent the proposed green thinking curriculum for elementary science schools. The researcher validated research articles on the basis of research relevancy, research focus, and positive expected outcomes of the proposed green thinking curriculum in both Saudi Arab and international contexts. The included studies were conducted in diverse cultures and backgrounds across various geographical regions such as Indonesia, the UK, and the USA.

Data Analysis Procedure

The data collection procedure is based on the in-depth descriptive analysis of research studies that described the curriculum followed in different countries, as well as specific indicators, principles, and initiatives they have followed or aimed to follow in future years to incorporate a green thinking curriculum. With the help of this in-depth review, the researcher obtained valuable knowledge and insights that are present in other green curricula employed in several countries (Kathleen et al., 2016), as discussed above. The review of educational literature in a diverse context of previous studies helped the researchers construct developed findings and results for this study to overcome the gaps in the Saudi Arab educational system. This study aids the researchers in constructing potential recommendations and suggestions for the Saudi elementary science schools to promote green education in their curriculum.

Discussion and Analysis

The study aimed to bridge the gap between the Saudi Arabian education system, especially for elementary schools, by representing a proposed innovative framework for green thinking curriculum. This study performed an in-depth thematic analysis of previous literature and research articles but found that there are very few researchers who discussed the importance and high prevalence of green thinking in the schooling education of Saudia Arab. Moreover, a few research studies conducted by Sharabi (2023), Alotaibi (2022), and Alsayed (2021) emphasized green education in the light of Green Saudia Education, but at the university level. There is an adequate need to present a fine and exclusive recommendation to the Saudi government in

order to promote the launch of green thinking in elementary science schools in Saudia Arab.

A new proposed green thinking curriculum for Saudi Elementary Science schools

The integration of a green thinking curriculum aimed to promote quality education among children with the practical implications of nature and environmental practices. The exclusive key features powered by the green thinking curriculum aimed to enrich the students' learning engagement in natural and environmental issues. According to Education (2024), the traditional elementary school curriculum of Saudia Arab is based on core subjects such as Arabic, Islamic Education, Mathematics, Science, and Art. However, a proposed comprehensive and effective plan to integrate into elementary schools in Saudi Arabia is based on a few key principles. The overall curriculum comprised Action-orientation, promoting the green curriculum, and delivery of quality education. These key principles are explained in core subjects such as science, which focuses on the ecosystem, biodiversity, and climate change processes, and mathematics, which teaches them about real-world consequences in terms of statistical forms such as graphical representations and pictorial data. Additionally, the subject of language and arts engages students in reading and writing about the most important concerns of environmental issues in terms of storytelling activities and, lastly, social studies for the in-depth exploration of human nature towards environmental hazards and issues. To administer these activities, the study also suggested activities and games that realistically apply to other green schools in different regions of the world. Below are some activities proposed by the study for the integration of a green thinking curriculum for elementary schools that empower them to take positive actions.

1. School garden activities to teach students about the importance of plants, maintaining the garden, and harvesting seeds, integrate the lessons about biology, food, ecosystem, and the hazards of cutting trees.
2. Recycling activities reduce waste production by collecting and segregating the identified waste, such as paper and plastics, that can be recycled. The schools should organize a competition between the classes to collect the recyclables. All these activities also promote recycling habits among the students.
3. Energy Consumption Awareness Programs also encourage students to think critically while using any sort of energy and engage them to monitor their energy consumption usage in school settings as well as at home.

In a similar context, the study conducted by Watson (2012) emphasized the integration of green schooling, which is considered a method of choice that provides knowledge to students about productive learning in a healthy and comfortable environment. Several studies emphasize the positive integration of green thinking in the curriculum as it promotes environmental education through exclusive hands-on practices and projects, with measurable results that help students strengthen their

social and civic skills (Mohammad et al., 2024; Fisher & McAdams, 2015; Sharabi, 2023).

Key features of green curriculum development

The Saudi education system should implement a green thinking curriculum to enrich exposure to their young students, to give them insights to improve their sense of belonging to this world and other objects around them. As proposed in the curriculum, knowledge about social and environmental sustainability encourages acceptance, understanding, a sense of responsibility, and empathy, which are essential for children who are in the developmental phases (The Yale Ledger, 2023). The integration of green thinking provides sensory experiences to the students with the advent of exclusive opportunities for hands-on learning experiences and exploration of different changes occurring in their surroundings, such as abrupt climate change, air pollution, waste disposal, and the greenhouse effect (Steg et al., 2014). In the same sense, a green thinking curriculum is exceptionally important to provide a calm shift to the thinking procedures of students, which sometimes creates an extra burden on their mental state. According to Alotaibi & Ismail (2024), green thinking or skills is not just a single course or discipline; it is an exclusive lifestyle or curriculum that needs to be harnessed in the advanced elementary curriculum of science students in Saudia Arab. Elementary school students are considered too young to memorize and implement the educational context that has emerged as a sense of sustainability among them. The green thinking curriculum also draws the attention of students to draw connections between what they learn in school and how their local surroundings reflect it, which in turn connects to their position in the global society. Therefore, it is critical that elementary school students in Saudia Arab should grasp different sorts of knowledge and information through a larger spectrum of global trends.

Impact of Proposed Green Thinking Curriculum on Students

The research conducted by Ahmad et al. (2019) highlighted that students who have regular access to the green learning environment exhibit less stress and anxiety. Elementary science school students in Saudia Arab surely have tremendous opportunities through the effective integration of green thinking in their curriculum, as it provides them with knowledge about the importance of environmental health, ecological knowledge, personal responsibilities, and empowered leadership qualities at an early age.

1. *Understanding of Biodiversity and Ecosystem:* Students would gain exclusive knowledge of different components of their ecosystem and their surrounding school environments, which fosters the importance of biodiversity in nature. The specific assessment method includes posters and presentation illustrations on the ecosystem that highlight the main concepts and the role of biodiversity in the environment.

2. *Student Engagement and Awareness Level:* The proposed green thinking curriculum would positively impact the students' engagement and awareness levels. The core values that will be regarded by the students are based on the principles of what is important for us as individuals and how we can opt for the options that are suited best for maintaining environmental integrity and protection (Sidiropoulos, 2014). The students can be assessed by conducting quizzes and tests in which they need to specifically discuss hazards caused by environmental issues.
3. *Fostering 21st-century skills:* The proposed framework would enhance the combined effect of developmental skills, enriching elementary science school students with creative, collaborative, critical, and problem-solving skills for effective communication and proficiency. The positive effect of the green thinking curriculum has acquainted students with both the technical and innovative skills to cater to the upcoming challenges within the context of sustainability and development. The criteria to assess 21st-century skills included performance-based questionnaires that allow students to actively participate in complex tasks to perform stimulated applications.
4. *Social Responsibility and Community Engagement:* The proposed framework would facilitate elementary-level students to work collaboratively with different students on various projects related to green thinking awareness. The students can be assessed by conducting projects based on teamwork and collective contributions, and by presenting their projects in front of other peers and educators.
5. *Collaboration and Teamwork:* The elementary-level students are focused on engaging in extracurricular activities that are beneficial for their physical and mental health. The positive outcomes of the green thinking curriculum encourage students to participate in different classroom discussions. The evaluation can be done on the basis of project-based learning on teamwork dynamics and the contribution of individual members to the project.

Comparative Analysis with Global Practices

The need to incorporate green thinking in education is also potentially recognized by the US, as more than 86 percent of the teachers and 84 percent of the parents encouraged the utilization of climate change education in their school education (Cho, 2023). However, the US education system also focuses on the potential implications of climate change or green education in the formal educational curriculum. Therefore, the current climate change curriculum in US education seems promising and fast-paced. From a larger perspective, the green thinking curriculum has been followed based on the UN's Sustainable Development Goals (SDGs). Now it is high time that the green thinking curriculum has been implemented gradually in Saudi Arab universities with the passage of time, but only a few initiatives have been taken to implement this in schools. According to

Hamill-Stewart (2021), a critical thinking course was implemented in the Saudi curriculum in 2018 that was hailed as a groundbreaking initiative in traditional teaching practices.

The school, located in Bali, Indonesia, has shown an example of a sustainable and green school environment by establishing Green School Bali, which has focused on improving sustainability and innovation among students (Green School Bali, Indonesia, 2024). However, the Green School Bali has incorporated innovative and creative programs such as managing organic gardens, bamboo bicycling, running, and waste management in order to provide real-life practical implications of these activities. In a similar context, Saudia Arab should also introduce green and sustainable school concepts on a larger scale, providing visual presentations to the students about managing gardening activities, waste management, and biodiversity that could be involved through project-based learning.

International School of Zug and Luzern, located in Switzerland, has dedicated a sustainable community for the students, which is responsible for organizing various fun activities for the children, such as clothing swaps, zero waste week, and biodiversity projects for the creation of habitats for local wildlife present in the school grounds. Similarly, it is recommended that the Saudi Arabian education system introduce similar sustainable initiatives for its students by providing them with an experience with eco-friendly technologies, renewable energy, and biodiversity projects in order to facilitate their educational needs.

In the primary school setting of the UK, the Green Curriculum has inspired elementary science school students to interact with nature, which enhances their interest in gaining knowledge about ecological concerns and the importance of environmental protection (Monte & Reis, 2021). The positive incorporation of green thinking in the UK educational curriculum has provided students with extensive comprehension skills so that their decision-making skills can be polished as they become adults. For the integration of green thinking in Saudia Arab, the core and existing curriculum needs to be transformed into an improved educational curriculum like that of the UK. The specific change should involve engaging the entire school community, such as teachers, students, parents, and local organizations, in the green thinking curriculum (Fadia Jiffry, 2013). The major part of the existing science curriculum of Saudia Arab consisted of theory-based learning, which lacks the practical implications and abilities of students. However, the promotion of hands-on activities among students at a very early age allows them to think critically and learn about the main issues directly (Kadbey et al., 2015). Overall, the comparative analysis recommended that the Saudi Arabian education context should evolve from the beginning of the policy level for accurate incorporation of green thinking and education, which has the tendency to standardize the elementary learning standards of science students

Challenges in Implementing a Green Thinking Curriculum

Meanwhile, Saudia Arab has stepped forward to implement a green thinking curriculum in higher education, as there is still a lack of implementation of green thinking curriculum in school settings (Alsharif et al., 2020). Moreover, university students are still facing challenges due to the implementation of a new green curriculum that has been surrounded by many new and innovative concepts and ideas that were unrecognized by students in their previous year of education. The implementation of green thinking in science curricula is characterized by multiple challenges that are related to cultural and traditional differences, Arabic language dominance, lack of global educational trends, less proficient teachers, and school management (Ávila et al., 2017).

Some of the most repetitive challenges include a lack of pre-existing environmental knowledge, a lack of experimental support, and traditional barriers towards innovative curricula. However, it is recommended that Saudia Arab should engage students in environmental awareness and knowledge from the initial years of education to overcome the barriers (Sharabi, 2023).

Saudia Arab is facing a lack of necessary material and human resources that can effectively enable green thinking in educational settings of institutions in Saudia Arab to carry out activities based on hands-on practices and project-based learning that are key components for green thinking (Abubakar et al., 2024).

The teachers associated with the education system of Saudia Arab are not particularly trained in sustainability and innovation practices in the realm of science education. Additionally, the implementation of green thinking requires precision and sufficient knowledge to overcome the barriers faced by students in the existing science curriculum (Abubakar et al., 2024).

The conventional methods of teaching in Saudia Arab are deeply rooted in Islamic learning, and conservative social norms restrict the facilitation of advanced and innovative educational practices (Sahin, 2018). The integration of green thinking, which dominantly focuses on modern scientific concepts related to environmental stewardship, can be affected by gender segregation in schools, which affects the results of collaborative learning opportunities among students.

Saudia Arab is facing challenges in aligning its educational goals with the current global education trends due to the traditional emphasis on rote learning and religious studies, which overshadows the importance of a green thinking curriculum to foster sustainable change in students (Singh et al., 2022). The organization often faced resistance to adopting change from conventional methods to established educational methods.

Results

Current Understanding of Green Thinking among Students

The integration of a green thinking curriculum fosters an innovative and sustainable advancement for elementary science school students in Saudia Arab by improving their understanding towards increment. The exclusive key features powered by the green thinking curriculum would enrich the learners with interdisciplinary learning qualities, along with engagement in natural and environmental issues. Green thinking has the ability to foster environmental responsibility among students at a very young age, which helps them take citizenship and ownership of their own actions. However, in order to create a sustainable and green future, the incorporation of green thinking instills a priority for the promotion of a sense of encouragement and involvement in the decisions. Not surprisingly, educational institutions throughout the world have revised and regenerated their curriculum to foster sustainable change in their countries through actions such as research agendas, policy making, community services, and workshop implication. The findings of the analysis highlighted that the recognition of the need to introduce green thinking in the curriculum is now an adequate task of the Saudi Arabian education system. However, the majority of the research studies emphasized sustainable university education in promoting green culture among the future generation. The findings revealed that the lack of opportunities for deploying environmental students in young elementary school students creates a sense of lack and glitches in spreading awareness regarding sustainable development.

A successful plan of green thinking in Saudia Arab by Vision 2030

The study effectively proposed dimensions for the Education Ministry of Saudia Arab by underlying multiple examples of Green and sustainable schools in developed and underdeveloped countries. The dimension of green thinking in Saudi Arab schools in the context of sustainability and environmental awareness among the students of the science curriculum is also aligned with the Saudi Vision 2030. For the successful integration of green thinking, Saudia Arab has actively participated in the National Program for Environmental Awareness and Sustainability Development, which is part of the National Transformation Program 2020. Additionally, the program aims to develop a sense of individual and collective responsibility for protecting and improving the environment. It fosters active community involvement in environmental issues, strengthens environmental culture, and supports nationwide volunteer initiatives for defense. Alongside, the program supports sustainable development by minimizing pollution, reducing the use of natural resources, and balancing the use of non-renewable and renewable resources. The goal is to address the environmental challenges by assessing the impact of green thinking in science curricula in elementary schools in Saudia Arab.

Recommendations of the Saudi Arabian Education System

Key findings from the literature indicated several recommendations for the Saudi Arabian education system by highlighting various positive benefits of implementing green thinking in the curriculum of science in their elementary school settings. This review effectively answered the research objectives with all the aligned recommendations and suggestions discussed above in order to provide useful insights for the upcoming researchers as well. From the researcher's point of view, future researchers can utilize this descriptive analysis as their pilot study to add their contribution in a similar context by presenting new and upgraded research that sheds light on elementary science schools in Saudia Arab. As a result, it is imperative to integrate and implement green thinking learning practices in science curricula that prioritize their abilities, values, and attitudes toward environmental protection, as it is necessary to live in a sustainable, strong, and resource-efficient environment for the safety of future generations. Overall, Saudi Arabia has already demonstrated its dedication and vision to the economic, social, and environmental facts emphasized in Vision 2030 (Yusuf & Lytras, 2023). For this purpose, higher educational authorities, administration, and instructors are advised to arrange and participate in conferences and workshops on the Sustainable Development Goals. For the progressive growth of green curriculum, the American Association for the Advancement of Science and the National Science Teachers Association, a nonprofit organization comprised of more than 24 states, collaborated to create the Next Generation Science Standards (NGSS) (Schweingruber et al., 2023). The major recommendations were made in all science classrooms, including instruction on man-made climate change, which should start from fifth-grade schooling. Additionally, other states created their own scientific standards, whereas forty-four states adopted the NGSS for the generation of their own standards (Cho, 2023).

Conclusion

In conclusion, this descriptive analysis review attributed various results by proposing an innovative framework of green thinking in the science curriculum for the Saudi Arab educational system. The main aim of this review was to contribute significant insights and recommendations for the promotion of green thinking in elementary school education. The findings of the study revealed that Saudia Arab has currently emphasized the integration of green thinking and environmental awareness through different programs such as the National Environmental Awareness and Sustainable Development Program, also included in Vision 2030. The findings of this study outlined several recommendations for the accommodation of an effective and high-prevalence modified curriculum that relatively focused on elevating green thinking in the elementary school curriculum of Saudi Arab schools. Additionally, the unique aspects of integrating green thinking also foster remarkable development among the students, related to their personal and educational development.

More generally, the findings are based on the profound suggestions that were highlighted in the most resourceful studies, which highlighted the importance of a green-thinking curriculum in elementary schools. In terms of the development of critical thinking, behavioral change towards sustainability, academic performances, nature awareness, the importance of biodiversity, and traditional and cultural shifts in education. Additionally, the in-depth analysis highlighted the initiatives and programs that are immensely integrated in Saudia Arab designed for university or higher-level education. In contrast, there are no interventions and initiatives planned by the Saudi Arab education minister that specifically target elementary-level education. Moreover, from a global perspective, there are many green schools that work progressively to raise environmental awareness and protection among young school-going students. However, this review provides a direction to the stakeholders in order to build students' interest and focus according to the exclusive introduction of the green thinking curriculum in science students. Overall, the findings of the study are based on strong evidence-based recommendations and suggestions to foster green education in Saudia Arab. There is an immediate need to pay attention to educational activities to promote sustainability awareness, technological change, and hazards such as the negative effects of global warming, excessive waste production, and water and land protection. The role of elementary school education for science students should be highly influential and show active involvement in fostering a green thinking curriculum in the students, which further becomes their lifestyle.

Conflict of Interest

The author of the study declares that there is no conflict of interest regarding the data collection procedures of this research. The findings of the research are unbiased based on existing literature in order to highlight the importance of green thinking in science curricula in elementary schools in Saudia Arab.

Declarations

Conflict of interest: The authors have no relevant financial or non-financial interests to disclose. The authors declare no conflict of interest.

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