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Hands-on Activities through Gardening: Building Twenty-First Century Skills for Lifelong Learning

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21st century skills, learning by doing, garden as a learning platform

Abstract

This article explores the contribution of students' garden-based activities to develop 21st century skills in the public schools in Nepal. It employed a participatory action research methodology, the research consisted of three purposively sampled intervention schools. The intervention involves the cultivation of flowers and vegetables, thus making gardening as part of the teaching and learning. Conversations, interviews and field reflections were the methods of collection of data, based on it, themes were made. The results indicate that the school garden enhances critical thinking, creativity, collaboration and problem solving skills as required in twenty first century education. In addition, students expressed the gardening activity as something that is related to what they have been learning and they appreciated it as a great learning platform. It encourages creative thinking, environmental sustainability and competence for lifelong learning.

Introduction

In the pursuit of transformative educational practices, the integration of school gardening into public schools has emerged as a powerful approach. Gardening cultivates life skills and fostering sustainable education (Baena-Morales et al., 2023). Recognizing the growing demand for such innovative practices, the Search Directorate, Tribhuvan University identified school gardening as a national priority research area. On October 13, 2022, our research team was fortunate to receive funding for the project titled 'Entrepreneurship through School Gardens for Sustainable Education in Public Schools in Nepal.' This funding was awarded after a rigorous competitive process involving proposal evaluation by two independent experts, a formal presentation, and intensive interviews. The research aims to address the critical gap in life skills development within the existing school curricula by embedding entrepreneurial activities into school gardening practices.

Public schools in Nepal are often deprived of opportunities to acquire essential life skills (Acharya et al., 2023). Traditional dogmatic curricula and teaching focus predominantly on theoretical knowledge, leaving little room for experiential learning that integrates earning while learning (Motta & Galina, 2023). As the principal investigator of this study, I reflected on my experiences as a school science teacher and university science teacher educator on how school education hinders students' creativity. The review of national policy documents and relevant literature showed to implement interventions to promote students creativity and develop life skills. School gardening activities such as vegetable and flower cultivation offers an ideal platform for equipping students to work, play and learn in the garden. It cultivates entrepreneurial life skills among the students (Acharya et al., 2023). With input from experts in the field, it is prepared a comprehensive proposal that aligned with the objectives of the national priority research program. The proposal's merit ultimately earned our team the opportunity to implement this innovative project in the sampled public schools in Nepal.

Filling the life skills gap extends the aim of sustainable education and community support as this research tries to do. It shows how participatory strategies can enhance pedagogical experiences that gets students ready to deal with 21st century problems (Rehman et al., 2023). The research was implemented as it was being implemented through student reflection ensuring its relevance empowerment and readiness for wide scale adoption. As we advance, the evaluation derived from the current initiative guides the future works in embedding entrepreneurial activities within the school system, to develop creative and resilient learners. Flower and vegetable gardening initiatives are crucial especially in public schools as they have the power to change and enhance creativity, development and sustainability. The work convinces students as entrepreneurs because they utilize the skills in conjunction with science education (Floris et al., 2023). The synergy of students, teachers and parents establish a culture of collaboration and innovation through the activities of the gardens. This study provides a theoretical account for conceptualizing science learning through collaborative and garden-based activities to engage students outside the structured classroom.

In this era, students need to develop 21st century skills that help to transform science learning from dogmatic lecturing to inquiry oriented learning. It navigates the complexities of modern life. Success in personal and professional domains demands more than foundational knowledge. It requires dynamic competencies collectively known as twenty-first-century skills. Twenty-first-century skills" consists of critical thinking, effective communication, cooperative interaction, creativity (4C's), emotional intelligence, adaptability, resilience, environmental consciousness, leadership, and digital literacy. The reorganized school-level curriculum in Nepal created by the Curriculum Development Center (CDC) is including these abilities in order to develop a student's preparation for global challenges and their readiness to adapt to a rapidly changing world. Global research highlights the significance of integrated approaches to teaching and learning in fostering these skills. Poláková (2023) emphasizes the importance of soft skills like creativity and problem-solving through interactive methods. Similarly, Thornhill-Miller et al. (2023) identify determinants of twenty-first-century skills, particularly communication, collaboration, and critical thinking, while

acknowledging psychological and social barriers to their development. However, ecological and life-oriented skills, which are critical for sustainable development, remain under-emphasized in existing pedagogical practices. This gap underscores the need for innovative approaches to skill development, particularly those that blend ecological awareness with life skills to foster sustainable education. In response to this need, the integration of school gardening into public schools has emerged as a transformative practice to cultivate life skills and promote sustainable education.

The study aims to bridge the gap in life skills development by embedding entrepreneurial activities into school gardening practices. It addresses an ecological awareness while fostering critical competencies like problem-solving, creativity, and collaboration. Through this initiative, the study strives to create a blueprint for sustainable education in the public schools. Drawing inspiration from Roshid and Haider (2012), the study emphasize fostering scientific literacy through education, This study extends the concept to include life-oriented soft skills like environmental awareness and problem-solving. By engaging students in cultivation of flowers and vegetables, the Green School Approach serves as a model for developing critical soft skills while contributing to the United Nations' Sustainable Development Goals (SDGs).

Furthermore, as Wang (2023) argue, the role of teachers in creating a supportive and engaging learning environment is indispensable. A study highlights that the importance of student-centered teaching, emotional involvement, and high-quality instruction in bringing about transformative learning experiences (Kong & Wang, 2024). Along with this initiative, the PAR study involves the STEAM (Science, Technology, Engineering, Arts, and Mathematics) principles that foster such competencies as inquiry-based learning, critical thinking, and collaboration. This approach not only addresses existing research gaps but also offers a transformative framework for promoting twenty-first century skills in the public schools in Nepal. This research intends to render practical information on the relationship between this green school approach and the development of skills, aiming link between school curriculum, eco-sustainability, and the development of 21st-century skills into the future of education. This study claims a solid footing for fresh forms of education that are eco-aware and, besides, are echoes of a sustainable development philosophy.

This study aims to expand the discussion about the necessity of finding creative pedagogical approaches that can practically embed skill life, ecological sustainability, and entrepreneurial actions into the context of school gardening. The study shall make sure proper incorporation of the students' personal experience learning to school subjects which will help bridge the gap in the current educational system. It focuses on teaching theoretical knowledge and not practical implementation. Building on the growing need for new educational concepts that include the development of life skills, environmental insights, and entrepreneurial activities, school gardening is the framework of the study. This research emphasizes experiential learning integrated into the curriculum in response to the obstacles in the conventional educational system, which often gives more weight to theoretical knowledge than practical application. Through participatory and student-centered approaches, the study aligns with national efforts to foster twenty-first-century skills, including creativity, critical

thinking, collaboration, and ecological responsibility. The Green School Approach, as a cornerstone of this initiative, exemplifies the transformative potential of combining science education with sustainability practices, offering a replicable model for public schools in Nepal and beyond.

The purpose of this study is to equip learners with crucial survival skills and meet the general goal of sustainable education. Through the use of the positive collaborations of the educational, entrepreneurial, and ecological sectors, the project wishes to create a wholistic learning structure that will enable students to face modern complexities. The outcomes and insights from this undertaking will give solid grounds for scaling up such activities and be the basis for setting policy. Above all, the study reiterates the need to rethink education as a lively process aimed at educating students for being active participants and sustainably solving problems in the world that is continuously changing and is tightly connected.

Methodology

The research is performed in the three ecological regions namely Rasuwa which is the Himalayan region, Kathmandu which is the hill region and Chitwan which is the terai region of Nepal to guarantee heterogeneity across geography and culture. From these regions, eighteen public schools were initially identified, and three schools were selected for intervention based on criteria. Baseline data collection included field visits to assess existing practices, challenges, and opportunities for integrating school gardening into the curriculum. The emphasis of the study rested on the collaboration of students, teachers and parents. Participatory Action Research (PAR) was employed in this study. As such the methodology adopted is cyclic in nature, planning, acting, observing and reflecting as these processes are interconnected to facilitate meaningful consultations among participants and improvement of practices on a continuous basis. During the implementation phase, school gardens were established as collaborative studies. Students formed entrepreneurship clubs, guided by science teachers as facilitators, while parents contributed technical knowledge and traditional gardening practices. This integration of expertise created a rich learning environment, embedding gardening into science and environmental curricula.

Over the last two years, intervention schools completed four PAR cycles, cultivating vegetables, flowers, and mushrooms as part of their gardening activities. Ontologically, the study recognized the reality of ecological sustainability and the existence of natural interconnectedness of life systems. Epistemologically, the research embraced subjectivism and constructionist paradigms, ensuring that knowledge was contextual, co-constructed, and actionable. Axiologically, the study inclusivity and transparency, fostering mutual learning and trust among participants.

The research was guided by interpretive and critical paradigms. Under the interpretive paradigm, the study explored participants' understanding of green consciousness and the integration of engaged pedagogy in achieving Sustainable Development Goals (SDGs). Reflective practices such as interviews, and narrative methods helped uncover socially constructed knowledge. The critical paradigm empowered participants to critically analyze ecological challenges.

Through iterative PAR cycles, this research highlighted the role of participatory methods

in promoting ecological consciousness and sustainable practices. By embedding action research within the educational framework, the study provided practical insights into fostering 21st-century skills, such as critical thinking, collaboration, and environmental stewardship, contributing to long-term educational and ecological goals. All these data were analyzed through thematic and verbatim approach.

Results

The study found that students enrollment that increased significantly in intervention schools, underscoring the appeal of practical, skill-oriented learning opportunities. Beyond the formal classroom learning environment, students adopted gardening practices at home, demonstrating the diffusion of knowledge and skills to their families and communities. This extended impact suggests that school gardening studies are not confined to the classroom; they serve as platforms for community engagement and empowerment. Increased parental involvement in school activities further reinforce school-community relationships, creating an ecosystem of mutual learning and support. These outcomes validate the role of school gardening as a tool for fostering sustainable development, social transformation, and lifelong learning. The hands-on engagement in school gardening turned classrooms into dynamic, experiential learning spaces. Teachers adeptly integrated gardening activities with classroom instruction, contextualizing theoretical concepts from science and environmental studies. As a result, students not only acquired technical skills such as flower and vegetable cultivation but also sharpen entrepreneurial competencies, including teamwork, problem-solving, and resource management. This holistic approach bridged the gap between theoretical knowledge and practical application, fostering deeper student understanding and engagement.

The success of intervention schools, which scaled its gardening activities to include cultivation of marigold and vegetables, exemplifies the broader economic and developmental potential of the study. The partnerships built with local governments and other stakeholders fostered this initiative to advance school gardens as marvelous tools for entrepreneurial development. By linking school activities with market demands, the study encouraged students and the community to envision and implement sustainable practices. This scale-up underscores the transformative capacity of integrating entrepreneurship into the school curriculum, showcasing how education can directly contribute to community resilience. It is also found that the collaboration among stakeholders through the iterative processes of planning, acting, observing, and reflecting was good. Despite limited facilitation, students demonstrated creativity, motivation, and a strong desire to contribute. Their participation reflected an intrinsic drive to learn and apply new skills, showcasing the study's ability to inspire learners across age groups. The ability to transfer local knowledge indeed emphasizes the elder's support in terms of motivation in combination with collaboration and especially with co-creation in achieving innovative ideas and learning from their peers.

This coincides well with the SDGs set by United Nations for this one focuses on quality education, sustainable practices and climate action. In doing so, school gardening acts as an ecological awareness promotion aim and the students' motivation in saving the nature translates into being active members of the global society. It seeks for resolving nature

compromising activities and improving human welfare. More so, the incorporation of SDG principles into school education ensures that the learners become more than just passive recipients of information. Participants developed critical thinking skills through activities such as soil preparation, crop protection and conserve environment. By integrating critical thinking, collaboration, communication, creativity, problem-solving, and digital literacy key twenty-first-century skills PAR aligns with the competencies and soft skills emphasized in revised school curriculum. The cyclic and participatory nature of PAR empowers students through hands-on interventions, enabling capacity building and ecological worldview development by connecting local and global contexts. The methodology underscores the importance of experiential learning, where students actively construct knowledge and transform their understanding through gardening with lived experiences. Moreover, the study advocates for reforming pedagogical tools to embrace a flexible and contextual science curriculum, fostering both individual growth and community engagement toward ecological well-being.

Discussion

The study's most significant finding was the marked increase in student enrollment in intervention schools, which underscores the appeal of practical, skill-oriented learning opportunities. This finding is related to the research conducted by Dewey (1938) who found that learning by doing help to develop creativity, passion and encouragement for the study. Relating to this finding, Kolb (1984) also revealed that learning is a part of gaining experience and it is only possible through hands-on activities. These practices help to link science curriculum with the real problems of the students and the community people. Proving theoretical knowledge has no meaning in the globalized world as one of the findings. Learning must be connected to the practical application of life. Learning connect with context. Science teachers bridged gardening activities with the learning topic. This finding is consistent with the Vygotsky who said that collaboration and engagement help learning. In the same line, Piaget (1978) said that learning strategies depend on the age of the students and these activities bridge practical part of human life. This finding not only deepened students' understanding but also made learning more contextual and engaging. This was supported by the literature (Freire, 1970).

It is found from the second cycle of PAR that students transform the knowledge of flower and vegetable cultivation at the home. This finding linked theoretical knowledge in to life contexts. The skills and motivation that students gained in the school as part of gardening helped them to contextualized teaching science topic. This finding is related to the theoretical perspective of 'diffusion of knowledge theory'that was advocated by Uzumcu and Acilmis (2024). This literature is in the line of the finding that school-based projects support students to innovate new ideas, techniques and knowledge. It then transmit to the local community in the wider scale that supports the involvement of community people for sustainable practices. This practice of learning in the schools strengthen the relation between the school and community that increases parental participation and engagement in the school that was advocated by Uzumcu and Acilmis (2024). The transformative build up among the students is one of the major findings. The degree of community empowerment and development is raised through such projects implemented in the schools. The involvement of parents and local community people created

a warm and trusted environment by mutual sharing of pain and success. This finding is consistent with Kessie (2023) who found that the significance of the family members to carry out sustainable practices. Schoool family and wider community visited school and engaged in the gardening activities.

School gardening develops entrepreneurial mindset among the students who engaged in the cultivation of flowers and vegetables. The cultivation of marigold, harvesting, selling the local market and gaining profit are the key findings related to entrepreneurial activities. These activities develop communication, team work, problem-solving and resource management knowledge and skills. These findings align with the previous researches. These study found that entrepreneurial education in the school through engaging students foster economic resilience and community development (Suguna et al., 2024; Mahmudin, 2023). Other researches also found that gardening help to transfer the knowledge from schools to the community that help to meet sustainable development goals through education for sustainable development (ESD) as researched by El Faouri and Sibley (2024). The transfer of knowledge from senior students to the juniors and from the school to the community through PAR process help to co-create knowledge. This finding aligns with Bandura's (2024) social learning theory, which emphasizes the role of observation and modeling in learning. It become the part of life long learning as outlined by (Canas et al., 2024).

The study's connectedness with the UN's SDGs is the ground for which it is more impactful and has a wider extent. It is noted that ecological literacy, such as conservation of flora and fauna, involve in sanitation programs, and planting flowers, is one of the activities. The discovery reveals that this research is in line with the views of Silva and de Assis, done in the same year (2021). Another significant focus of the study was the development of creative thinking as mentioned in the The National Curriculum Framework of Nepal (NCF, 2019). It also, as a result, helped to develop cognitive ability among the learners (Setiawan, 2021). The development of intrapersonal skills such as self-regulation, perseverance, and the setting of goals was another achievement. Students acquired skills like initiative-taking, keeping control of resources, and dealing with difficult moments. One such ability is the ability to take responsibility for your own growth, which is mentioned in the framework for the Twenty-first Century (Alam, 2022). The practice of the project enabled participants to develop inter-personal skills, for example, communication, teamwork and mutual support, which prepared the students for the many different roles they would have to play in the future. These findings are consistent with Vygotsky's (1978) promotion of the social aspect of learning and the importance of collaborative efforts in cognitive development. The project, on the one hand, proved that the means of teaching gardening affiliated schools have to the practical acquisition of knowledge and skills can be potent but, on the other hand, it also showed some weaknesses in its implementation of Nepal's integrated curriculum. Teachers and facilitators often lacked sufficient training and resources to fully integrate experiential learning into their practices. This finding echoes previous research that identifies teacher professional development as a critical factor in the successful implementation of innovative teaching approaches (Nilsson & Göransson, 2021). Addressing these challenges calls for the design of special professional development programs that would provide the teachers with the skills

and knowledge to implement experiential learning in the right way.

However, the thematic combination of several disciplines through gardening activities was able to offer a practical connection between theoretical and practical learning. This comprehensive and integrative approach is consistent with the integrated curriculum design that stresses connections across subject areas to enhance student understanding and engagement (Lytras et al., 2022). Through the coordination of gardening activities with subjects, the project was able to show how experiential learning can allow students to have an educational experience that is more inclusive and meaningful. The study findings made it clear that the PAR methodology is quite beneficial for the sustainability and environmental education in the community. The cyclic and participatory nature of PAR empowered students through hands-on interventions, enabling capacity building and the development of an ecological worldview. This way of thinking goes hand in hand with (Acharya et al., 2023) the push from the local to the global standard the improvement of the worldly mindset. It is the combination of PAR with the above-mentioned skills that students acquire a deep knowledge of the subject, become up to date with the latest learning and teaching approaches, take an active part in the learning process and exhibit their analytical, problem-solving, creativity, and digital literacy skills that the language focus is PAR that is in line with twenty-first-century skills required in the curriculum.

Conclusion

The successful nature of the concept is due to the involvement of different activities in the curriculum. And this program scored high on student engagement, community forming, and sustainable living issues, which was very instrumental in bringing about academic, social, and economic transformation. From now on the productivity of the project will be scaled up through teachers' focused guidance and more green projects in schools for better and more effective learning. Innovation and experiential learning programs also can hasten this process. In that, they can be the key launchers of an inclusive and sustainable education system. Through the removal of the obstacles anticipated and the enhancement of the functionalities enumerated in the study, the future programs can become more efficient tools for the use of education in the field of sustainable development and social transformation.

Author's contribution

The first author prepared the manuscript. The second and the third authors finally edited the paper. All the authors agreed to publish this paper.

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