JTAR

EDITORS

GIL NAIZER
APRIL SANDERS
LAURA ISBELL
TAMI MORTON
SUSAN WILLIAMS

Journal of Teacher Action Research - Volume 7, Issue 2, 2021
practicalteacherresearch.com, ISSN # 2332-2233

JTAR

Journal of Teacher Action Research
Volume 7, Issue 2, 2021

JTAR

About the Journal

Founded in 2013, the Journal of Teacher Action Research (ISSN: 2332-2233) is a peer-reviewed online journal indexed with EBSCO that seeks practical research that can be implemented in Pre-Kindergarten through Post-Secondary classrooms. The primary function of this journal is to provide classroom teachers and researchers a means for sharing classroom practices.

The journal accepts articles for peer-review that describe classroom practice which positively impacts student learning. We define teacher action research as teachers (at all levels) studying their practice and/or their students' learning in a methodical way in order to inform classroom practice. Articles submitted to the journal should demonstrate an action research focus with intent to improve the author's practice.

Editorial Team

www.practicalteacherresearch.com

REVISITING SCHOOL SCIENCE CURRICULUM THROUGH SCHOOL GARDENING PARTICIPATORY ACTION RESEARCH PROJECT IN NEPAL

Kamal Prasad Acharya
Tribhuvan University, Nepal

Chitra Bahadur Budhathoki
Tribhuvan University, Nepal

Abstract The NORHED/Rupantaran project designed participatory action research to develop science curricula discourse through school gardening activities at community schools in Nepal. To this end, as a Rupantaran sub-project, looking through the theoretical lens of complexity thinking, the present study creates a venue of science learning through garden-based pedagogy. This study explored the ways schools, science teachers, and students may foster a sense of agency in school science curricula through life-based experiential learning. The findings show that such participatory and generative approaches to developing school gardening curricula is productive for science learning. The evidence from participatory action research experiences in actual school settings provides new insights for policymakers to transform school science curricula. Further, the study findings suggest ways for collaborative knowledge production through school gardening in a contextual setting, which is often a neglected area in community school science teaching and learning. The implications of the research findings could contribute to policy level discussions pertaining to science teachers' professional development. Further, this study suggests the need for practice-oriented research and studies to continuously inform the ways to improve the national level school science curricula.

Keywords: teacher action research, community schools, experiential learning, participatory action research, school garden, science curriculum transformation

Introduction

Science curricula reforms in almost all parts of the world incorporate meaningful student engagement (Fleming, Kenyon, Kenyon, & Upadhyay, 2015; Kloser, 2013; Olitsky, 2007; Vedder-Weiss, & Fortus, 2013). Almost all the science curricula in schools in Nepal give priority to areas of study rather than to practical applications. The major concern is that school science curricula in community schools in Nepal shows epistemologically theoretical understandings (Acharya, 2016). Due to the lack of practical activities and the lack of skills development through real field experience, the desired change put forward to reform science curricula keeps an emphasis on garden-based science pedagogy. To address this need of transformation, in recent years, the

Ministry of Education, Science and Technology (MoEST), Government of Nepal (GoN) has prepared *Green School Guidelines* based on draft education policy *One Garden One School* to reform school science pedagogy throughout the country. This highlights the need for urgent improvement in students' and teachers' capabilities to develop skills, specifically *hands-on learning and teaching* through gardening activities. Science learning using school gardening activities is an immediate initiative in Nepal. Activity-based instruction in teaching and learning science helps to strengthen students' higher-order cognitive skills, such as analyzing science content and creating original thought as well as increasing knowledge (Denzin & Lincoln, 2008). In this context, Acharya (2018) suggests that students exposed to hands-on science instruction frequently achieve significantly higher scores in science than those students who experienced only minds-on activities in learning activities. Also, the policy reform documents the value of activity-based instruction through school gardening activities (Robinson, 2018).

Literature Review

Science teachers in Nepal schools need to help students explore scientific ways of talking about *everyday practices.* They should, also, provide them with opportunities to engage in scientific discourse. Discourse between the teachers and students, with the curriculum based on school gardening activities, helps to develop new insights for learning science. Developing classroom discourse is arguably one of the greatest challenges facing teachers in the classroom (Robinson, 2018). The existing science curriculum and instructional practices provisioned by the National Curriculum Framework (NCF) has given priority to engaging students in meaningful science learning. As a school science teacher and a university science teacher educator, I am continually facing the challenges of augmenting the level of discourse in my classroom by engaging students in hands-on activities such as the study of leaves, roots, locomotion of earthworms, and measuring the pH of water and soil.

As co-researchers in participatory action research (PAR), we believe that science learning is conceptually significant when we are able to engage students in the school garden. Learning occurs in action and involvement starts with the relationships (Ping, 2015; Watts & Pajaro, 2014). My assumption as a co-researcher in PAR is that action and experience are the basis for knowledge. This research seeks to understand how students and teachers collaborate in transforming teaching and learning activities to (i) support students' learning by engaging with a school garden; and to (ii) co-create knowledge through garden-based activities. In crafting the responses to this inquiry, we (I as a co-researcher, students, and teachers) adopted two approaches: (i) learning through action (de Beer, 2018; Lee & Yang, 2019); and (ii) participatory action research, completing work on observe-plan-act-reflect phases (Boog, Slager, Preece, & Zeelen, 2019; Chevalier & Buckles, 2019; Mirra, Garcia, & Morrell, 2015).

From a theoretical perspective, I reconsidered Laudonia et al., (2018) when looking at how students engage in action learning, a pedagogical process that involves learners working and reflecting together on real situations in the students' work setting. PAR is a research process wherein students participate in actions both as subjects and objects with the explicit intention of bringing about change in the setting under study (Acharya, 2019; Laudonia, Mamlok-Naaman, Abels & Eilks, 2018). In this reflection, as a part of PAR, I explored how action learning accomplished the cycle of PAR based on the objective of converting experience into practical learning. It completed the cycle of engaging in research, based on experience to co-create knowledge.

From a practical standpoint, we found many instructional strategies and practices that promoted the value of experiential learning by the meaningful engagement of students in the garden. Teachers used experiential activities to simulate real-life experience (Lewis, Herb, Mundy Mccook & Capps-Jenner, 2019). These real and practical endeavors, often referred to as experiential learning, can be quite effective in giving students an opportunity to use concepts in action. Connecting learning through experience, in reference to the works of Dewey, discusses that reflection plays a central role in the learning process and is vital for making meaning of the experience (Feldman & Rowell, 2019). When given ample freedom to engage in experiential activities, students actively construct the necessary knowledge to make sense of their environment (Maibaum, 2017). Research participants took part in adequate discussion and argumentation to develop the garden-based curriculum. Knowledge exploration in PAR advocates democratic relationships (Feldman & Rowell, 2019) between research participants.

We focus this article on the PAR methodology to create garden-based pedagogy for providing teachers and student-researchers with a tool that may lead, in conjunction with a framework for discussion for curriculum change, to a better understanding of how student engagement and interactions promote meaningful learning.

Research Question. The research question is: How can active student engagement utilizing a school garden expand scientific conceptualization through a contextual curriculum in a basic level community school in Nepal?

Tribhuvan University and Kathmandu University from Nepal, in collaboration with the Norwegian University of Life Sciences (Norway) has initiated the *Rupantaran* project (*Transformation in the Nepali language)*, 2016-2021, entitled 'Innovation in Teaching and Learning through Contextualized Approaches to Increase the Quality, Relevance, and Sustainability of Education in Nepal'. NORAD funded this project to work with innovative, participatory, and rights-based approaches to improve teaching and learning outcomes of basic school students through community empowerment and sustainable improvements.

Methodology

Research Design and Research Participants. A qualitative research design was used in this study based on the PAR approach. The participants of this research study included one hundred and forty students (6th and 7th graders) of an action school (Intervention school in participatory action research) and two science teachers teaching at the same level. Science teachers were experienced in their field and had taken nine months of teacher professional development training conducted by the Ministry of Education, Government of Nepal. Teachers were innovative in their own teaching practice as they had been trained in activity-based learning, however, they were lacking the self-confidence to participate in, and actively contribute to learning from school gardening activities. Also, they were lacking the confidence needed to prepare contextual science curriculum based on school gardening activities with collaboration from the students.

We conducted this research within a rural community school located in Province 3, Chiwan, Nepal. At the beginning of PAR in the action school, sixth and seventh graders and teachers were invited to participate in a series of dialogue conferences in workshops, formal and informal conversations, and interviews conducted within and outside the school premises. The school head teacher, science teachers, and students participated in the workshops before and after the gardening experience. Out of the one hundred forty student participants, one hundred thirty accepted the invitation. Of the ten remaining, six eventually decided to participate and four chose to abstain from the gardening activities, referring to an untidy working situation with the soil in the garden.

Data Collection Instruments and Analysis. Participant observations, dialogue conferences in workshops, field notes during students' gardening activities, and conversations with the teachers and students were the major tools used for collecting data. Four dialogue conferences in workshops and twelve participant observations were conducted as the main method of data collection in the form of a qualitative approach. The recordings of our meetings were transcribed and analyzed using the theory of practice architectures. The reading of Habermas (1987) encouraged me to use communicative spaces as ideal in planning meetings. The progress of work followed the cyclic process of PAR via observing-planning-acting-reflecting (Hearn, Swan, & Geels, 2019; Tracy, 2019) where different steps may not always follow a chronological order. In the workshops, the main themes and concepts were discussed thoroughly and systematically. As a participatory action researcher, another ambition, linked to communicative space, was to establish a broader understanding of others' point of view and to achieve *unforced consensus* about what needs to be done to improve practice. The unforced consensus is an agreement that is not mandated upon anyone. According to Armstrong and Tsokova, (2019) only democratic dialogues between the research participants are useful for finding solutions in the workshops and conversations regarding school gardening activities. In all phases of PAR, every research participant was given an opportunity to speak freely and given time to reflect on, and bring to light, diverse opinions and understandings. Different tools and techniques designed to promote reflection and dialogue were used (Brydon-Miller, 2018; Denzin & Lincoln, 2008; Lorenzetti & Walsh, 2014).

Data were focused on the teaching and learning activities performed by the teachers and students in the garden, interactive dialogues, and preparing the garden-based sample curriculum. Reflective field notes from workshops, observations, and conversations were transcribed, translated, and analyzed using thematic content analysis. Themes emerged from the data through a process of open coding. Open coding involved reading, re-reading, and reviewing the transcripts five times, while writing notes and codes in the manuscript to describe all thematic content. Codes were transcribed into a coding sheet and formed into categories. Finally, thematic content analysis was performed in which data were coded to identify emerging themes and patterns which were then categorized and interpreted according to their relationship to the research question and theoretical perspective. Also, participant observation and conversations were conducted during school gardening activities. Detailed field notes from all observations, conversations, and dialogue were recorded.

Since all data were collected in the Nepali language, the data analysis was performed in Nepali. During data analysis and write up of the manuscript, the original Nepali quotes were used as much as possible to prevent losing meaning as a result of translation. The quotes in the final manuscript were translated by the first author and checked by the second author.

Co-researcher (first author) Positionality. As a school science teacher and a university teacher educator, I have used reflections from my own teaching, learning styles, and practices. As an educator researching the practices of teachers, my research is rooted in science pedagogical orientations, yet I am uniquely positioned, as Greene (1993) has stated, as a stranger in a classroom that is not my own (Robinson, 2018). I describe my own positionality as an insider in collaboration with other insiders, having the benefit of entering this research space with new views to observe students, as a stranger might for the first time, look inquisitively and wonderingly on the world in which he lives (Greene, 1993, p. 93).

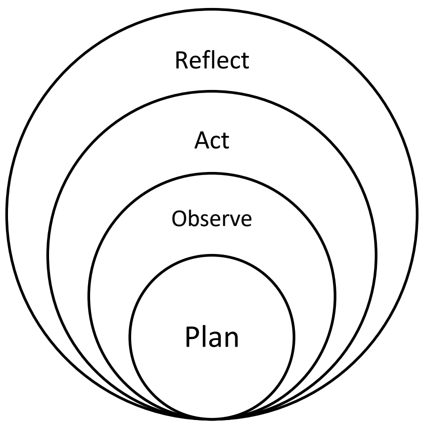

Figure 1: Nested Research Phases

Action Research Practice: Participatory Collaboration. In determining this participatory action research design, we maintained a cyclic thinking perspective for the research phases, with a view to the participatory and cyclical process (Carr & Kemmis, 1986; Nyanjom, 2018), wherein new knowledge arises out of actions and, in turn, informs new actions. Our design for the research cycles involved four key phases. Figure 1 shows nested circles identifying the phases of PAR and indicates how each phase arose from and embodied the previous one.

Considering the phases of the PAR, the following activities were done in collaboration with the students and science teachers.

Observing and Planning: Dialogue Conferences through Collaborative Inquiry. To begin PAR in an action school, planning was done to analyze the science curriculum, science textbooks, and

possible school gardening activities. The action school's needs, in terms of its probable garden area, classroom facilities, science laboratory, and science performance scores in the class of six and seven graders were explicitly studied. The existing problems in teaching and learning science with grade six and seven students and the gaps in actual classroom teaching and learning activities were explored. The science curriculum was analyzed in terms of its content, objectives, activities, and assessment techniques by meaningfully engaging students and teachers through a series of dialogue conferences in the workshops.
Students shared their experiences with the science teachers and the first author through power point presentations and by taking part in dialogue conferences in the workshops. Students and teachers designed and implemented sample curricula based on school gardening activities as a part of the teaching and learning experience. Also, science teachers were committed to applying students-designed curriculum in their further teaching. Research participants prepared the guidelines to frame the sample garden-based curriculum under the themes of science curricula, activities and learning science (Appendix A).

Different topics such as pH of soil, moisture level in the garden soil, soil textures, filtration and decantation processes, plant types based on leaves and roots, seed germination, compost manure preparation, photosynthesis, and transpiration processes were linked to the school gardening activities. The role of green plants for environmental conservation and their importance in human life can also be studied in the school garden. All these teaching-learning activities were linked with school gardening activities by the collaboration of science teachers. Intervention guidelines were prepared for research participants in the intervention phases of PAR. In the planning phase of PAR, they prepared the curriculum components and learning outcomes with detailed descriptions for effective implementation of school gardening activities (Appendix B).

To implement the garden-based curricula, students and science teachers have chosen an open area beside the main school building. They selected a garden site that would provide enough sunlight, water, and good quality clay for planting. Students prepared sample curricula based on the themes and topics, learning outcomes, and gardening activities gleaned from the series of dialogue conferences in the workshops (Appendix C). Based on the prepared sample curricula (Appendix B), learning outcomes were designed through the cooperation of students and science teachers.

Learning activities and a sample curriculum linking various gardening activities was prepared by students and science teachers working together. Curricula was prepared in the planning phase of PAR approach (Appendix D).

Based on the PAR (plan-observe-act-reflect) phases, a sample curriculum was prepared with the collaboration of science teachers and students. Garden-based science curricula was prepared through democratic dialogues and collaborative inquiry of PAR researchers, science teachers, and students.

Acting Phase: Garden Intervention. School gardening and intervention activities according to the PAR approach, began by using the experiences of research participants. This is the third phase of PAR in which sketches of the school garden were designed by 6th graders from a dialogue conference in a workshop. One of the best sketches was selected by teachers and students through democratic dialogues. The school garden was designed to grow vegetables and flowers. Themes for the school gardening and science curricular outline were prepared by students and teachers in collaboration (Table 1).

Table 1: Details of Participatory Intervention Guidelines

INTERVENTION TOPICS	**FROM THE STUDENTS' NOTEBOOK**	**SCIENCE CONCEPTS**
ONE PERIOD (45 MINUTES) PER WEEK. ONE PERIOD FOR THEORY AND ONE PERIOD FOR PRACTICAL LEARNING IN THE GARDEN		
SOIL IN THE GARDEN	Soil is crucial to life on Earth. Soil can be defined as the organic and inorganic materials on the surface of the earth that provides the medium for plant growth. Soil develops slowly over time and is composed of N, P, Na, K, etc. Weathering is the mechanical and chemical process by which rocks are broken down into smaller pieces. As rocks are broken down, they mix with organic materials that have originated from living organisms.	Meaning of soil, the process of soil formation, weathering, minerals, decomposition
TYPES OF SOIL	Sandy soil consists of small particles of weathered rock. Sandy soil is one of the poorest types of soil for growing plants because it has very low nutrients and does not hold water well. This makes it harder for the plant's roots to absorb water. Silt soil has much smaller particles compared to sandy soil and is made up of rock and other mineral particles which are smaller than sand and larger than clay. It is this smooth and quite fine quality of the soil that holds water better than sand. Silt soil is more fertile compared to the other three types of soil. Clay has the smallest particles, tightly packed together with each other, and with very little or no airspace. This soil has very good water storage qualities, making it hard for moisture and air to penetrate it. Loam is the best type of soil, formed by the combination of sand, silt, and clay. It has the ability to retain moisture and nutrients; hence, it is more suitable for farming.	Types of soil. sandy soil, silt soil, clay soil and loamy soil

TWO PERIODS PER WEEK (TWO PERIODS FOR SOIL PH AND TWO PERIODS FOR COMPOST PREPARATION). TWO PERIODS WERE ALLOCATED FOR THEORY AND TWO FOR GARDEN-BASED PRACTICAL ACTIVITIES.		
PH SCALE & SOIL PH	The pH scale was used to measure how acidic or basic the soil is. pH scales range from 0 (most acidic) to 14 (most basic). Pure water is neutral (pH 7). Soils with pH below 6 are considered acidic and above 8 are considered basic. We found that the pH of the garden soil was 6.5 which showed us that the garden soil is slightly acidic.	Acid, base, neutral, pH scale, and pH
TWO PERIODS/WEEK (ONE WEEK'S LESSON)		
COMPOST	Compost manure is good for farming. It makes the soil fertile. Students collected compost manure from home for the garden. Later on, they started preparing the compost for decomposition by adding leftover food items, fruit peels, leaves, and dry grass available from the school.	Compost manure, the fertility of soil, decomposition, earthworms, organic substances

Reflecting Phase: Assessing Where We Are. In the last phase of PAR, students' activities were observed by science teachers and the teachers' activities were observed by the co-researcher. Major events were recorded in each phase. For the science teachers, gardening activities provided critical reflective opportunities for science teaching opportunities. As a new methodology, the school garden significantly opened up discourse to more meaningful exchanges. These were documented through observation, field notes, and increased student-to-student interactions with meaningful engagement through hands-on activities. Students demonstrated more sustained lively activities and accountability towards learning science with and without the presence of science teachers. For the researcher, garden-based activities provided an opportunity to see students learning science. Through the collaborative inquiry and with democratic dialogues, the PAR researcher and the science teachers gained a fuller understanding of the process as they watched and listened to the students share, build, and ultimately explore knowledge together.

After six-months of continuous engagement in the school garden, the action school was exemplifying overall academic quality in science teaching and learning. We (the teachers and the first author) noticed the transformation in science pedagogy from the silent mode of the lecture method to activity-based learning through outdoor activities. All gardening activities were linked to the garden-based science curricula and also linked to real learning through participatory action research.

Results

The present study provided a rich insight into how science teachers and students may conceptualize and facilitate the concept of experiential learning from the garden. The findings relating to curriculum construction based on school gardening activities proposed by this study are an important aspect, going forward, in designing and implementing science curricula based on the *One Garden One School* education policy in Nepal. The knowledge of praxis (knowledge in action) flows from the position that action and reflection are inseparably amalgamated. And the school can transform teaching and learning science from the silent method of lecture to an activity-based pedagogy. This study, in the community school in Nepal, draws connection between action and reflection, specifically gardening activities and transforming science pedagogy with the curricula developed by the students and teachers. Students' garden experiences led to critical consciousness and could then lead to further action in transforming science pedagogy in the community schools in Nepal.

Students, generally, had a positive attitude towards learning science through school gardening activities and they frequently used a garden to link science and learning. One of the students shared his experience in this way: "The school garden provides first-hand experience for learning science and I will never forget what I studied in the garden." Similarly, another student stated:

> The school garden is an important experiential class that engages us in a variety of science learning activities. Measurement of pH of garden soil, identification of layers of soil, separating humus from the sandy soil, and the importance of compost manure for the growth and development of plants are only a few topics that we learnt from the school gardening activities.

During gardening activities, students learned real-world science applications by measuring plots and recording the growth of plants. As they worked with the collaborative inquiry, they learned to care for living things and developed important discipline and collaborative life skills such as patience, responsibility, co-operation, and understanding. Science teachers believe the gardening program definitely helps in teaching science by meaningful engagement of students in the activities. Also, the school gardening program has grown further to engage students through learning from the school garden campaign, which aims to transform science pedagogy in community schools in Nepal. In working with science teachers, one of the students shared this, "Experiences change over time in engaging in the school garden activities." She further stated that "Garden activities make us realize the importance of school garden and I think it is important to provide a real taste of learning". After engaging in the garden for more than a week, she is now eager to pursue more areas of study related to garden activities. Her activities, after intervention, showed that she had developed the skills needed to handle tools and seedlings. She began to see herself as one of the members in the learning community. Through reflective dialogue conferences with the other students and the co-researcher, she became aware that her activities were part of the entire group's learning activities.

Also, the school head teacher appreciated the use of the school garden for the overall physical, mental, and social wellbeing of students. Furthermore, it was found that involving students in soil preparation, solid waste management, compost preparation, planting crops, and harvesting techniques made the science content more understandable. At the same time, science teachers linked curricula in an integrated approach with gardening activities. It became a perfect learning opportunity for students. It was found that science teachers were happy to share the work they had done collaboratively with the students in developing the 'garden-based science curricula.' One of the science teachers in an informal conversation stated:

> Today I am happy. We are applying a newly framed garden-based science curriculum to fulfill the learning objective and our work is being recognized. Our curriculum is functioning. It works effectively. I am able to design curriculum and implement it in teaching science.

Another science teacher sharing in a dialogue conference after intervention in the garden said this:

> The newly framed sample science curricula contain gardening activities to maximize students' exposure to learning chemistry such as pH of the soil, types of soil, humidity, nutrients, and air, water, and soil minerals. School gardening activities such as planting, tending, harvesting, preparing, and then linking to the science curricula were completed by the continuous engagement of students and teachers.

Overall, the participating students shared their perceptions about the school gardening activities in a positive way. Research participants had a chance to appreciate the way in which theory and practice link, to investigate their implicit theory, to construct collective knowledge, and to participate in reflective practices. It was also found that PAR is useful for teachers' professional development and it can reveal changes in the teachers' discourse throughout an academic session.

Discussion

This study aimed to revisit the school science curricula through school gardening PAR activities and collaborative inquiry among the students and teachers in the community schools in Nepal.

The qualitative research on framing science curricula based on school gardening that does exist, has focused on students' and science teachers' gardening experiences, mainly reporting constructive gardening experiences (Block et al., 2012; Bowker & Tearle, 2007; Rodriguez et al., 2015; Somerset, Ball, Flett, & Geissman, 2005). However, none have shed light on the role of local people and their ideas and suggestions for improvements in designing science curricula using school gardens. As students are the main intervention manipulators, given an occasion to opine their understandings on what they believe works and what does not, exceptional contributions for school gardening activities and developments can be gleaned.

Consistent with previous participatory action research on students' gardening experiences (Block et al., 2012; Rodriguez et al., 2015; Somerset, Ball, Flett, & Geissman, 2005), this research study illustrates that science teachers and students were passionate about learning science when gardening and the curriculum they had prepared were linked with science curriculum. Similarly, Acharya, Budhathoki, Bjønness, & Jolly, (2020) argued that school garden is an excellent venue for activity-based science learning. Similar to findings by Passy (2014), students undoubtedly preferred school gardening activities for learning. Indeed, earlier research has shown that school level students desire activity-based science learning over lecture methods, and when activity-based methods are used, the students develop a more constructive outlook towards learning science (Lawton, 1997; Selim & Shrigley, 1983). On the other hand, the head teacher did not like such activities because they presented a problem with managing extra periods for the gardening activities.

Result of this study indicated that student's main impetus for engaging in the school gardening science learning is 'having fun', which is similar to the result found by Bowker and Tearle (2007). This PAR was directed towards real-life activities to co-construct collective wisdom by the meaningful engagement of students and science teachers in the school garden. It was similar to the study done by Acharya (2019) which showed that learning by doing and learning by living are the purposes of science learning through school gardening activities. It transforms teaching and learning science from the lecture method to the activity-based method as Indraganti, (2018) argued in agreement. Furthermore, this research could lead science teachers to contribute to resetting the possible ways of involving students in activity-based learning by constructing an activity-based curriculum (Jacobs, 2018; San Antonio, 2018). Also, this research suggests there is potential for educational reforms in teaching and learning in the community schools throughout Nepal. School gardens and science learning collaborative activities could enable teachers to transform the rooted structure prescribed by policy to move teaching and learning forward. In this connection, Lewis, Herb, Mundy-Mccook & Capps-Jenner (2019), found that participants in action research explore life-enhancing pedagogy. This conclusion has significant implications that could guide science teachers and school head teachers in developing new and innovative approaches to science learning with the garden.

In addition, designing school curricula through the collaborative inquiry of teachers and students proved to foster better understanding of how learning approaches help students gain a sense of pride. Furthermore, this study may help to shift the perspective of science in school education. By using the term, *a transformative perspective (*Acharya, 2018; Worthen, Veale, McKay, & Wessells, 2019; Seniuk, Ingram, Friesen, & Ruth, 2019)*,* I mean that students and teachers involved in PAR share their perspectives through dialogic conferences, trying to reshape shared perspectives and construct new values. The teachers then, interconnect what we value concerning knowledge adoption. In this line, McNiff (2014) explains that "the capacity to negotiate values should be the main criterion in action research" (p. 181). It needs to find out how science teachers cooperating in PAR in gardening activities, can encourage students to transform by participating in hands-on activities (Kafyulilo, 2018; Otienoh, 2015; Whalen, 2016). This may be a topic for my further research.

Also, we hope that PAR to some extent may transform the silent mode of science teaching in a teacher dominated classroom to the collaborative and active engagement of students outside the classrooms in exploring science. We hope that this study will act as an invitation to other school science teachers, the officials of Curriculum Development Centre, researchers in relevant fields, and policy-makers to engage in public debate about the current science education curricula, where teaching and learning in a classroom context has been constantly influenced by dogma. We also hope that such open debates will lead to suggesting a new perspective on science teachers' professional development programs that are more teacher-centered and based on a bottom-up approach.

Implications

This research has several implications for transforming the silent mode of school science teaching to activity-based learning through gardening activities. First, it seems important to focus on the involvement of students in open ground, as teachers think this is important (Katsarou & Sipitanos, 2019; Ping, 2015). The potential to work in an environment safely and with no fear needs more emphasis (Kapoor, 2019). Second, to increase the effects on the students' learning behaviors it will be important to involve science teachers in making the school garden attractive and colorful. Furthermore, it is recommended that there be better integration of the school garden into the science curricula.

Conclusion

Although the action school in this study has a school garden, the perceptions towards the school garden and perceived problems and barriers for the implementation were overall similar. In general, science teachers and students were positive about the school garden, but encountered some practical issues which needed to be solved to improve efficiency. The findings of this study have led to recommendations and tips for future school garden practices.

This study gives valuable insight into the implementation, practices, and perceptions of students and science teachers towards school gardening activities for science learning, however, it also has some limitations. At first, the school science teachers shared that time constraints were the main reason for not participating in daily gardening activities. Second, the action school is located near a town area, which may limit generalizability to schools in rural regions. A third limitation is that participating students were selected only from grades 6 & 7 based on literature and experts' suggestions, which could have resulted in bias as it is possible that the most motivated students are only from grades nine and ten.

Acknowledgements

We would like to thank the teachers and students who engaged meaningfully in school gardening activities as part of science learning through this study. This paper has been prepared with support from NORHED/Rupantaran project entitled 'Innovations in Teaching and Learning through Contextualized Approaches to Increase the Quality, Relevance, and Sustainability of Education in Nepal' which has been jointly implemented in Nepal by Tribhuvan University (TU), Kathmandu University (KU), and the Norwegian University of Life Sciences (NMBU). The authors are grateful to the project coordinators for their valuable support. This research was funded in part through a NORHED/Rupantaran project (2016-2021), agreement number 2016Q2A04.

About the Authors

Kamal Prasad Acharya is a lecturer of science education, Department of Science and Environment Education, Central Department of Education, Tribhuvan University, Kathmandu, Nepal. He is a PhD fellow of NORHED/Rupantaran project under the Graduate School of Education, Faculty of Education, Trihbuvan University, Nepal. His area of expertise is science teachers' professional development, inquiry-based learning through school gardening for sustainable society through participatory approaches. He would like to thank Birgitte Bjønness (Norwegian University of Life Sciences, Norway) for providing scholarly guidance and correction in this paper. Email: kamalacharya@tucded.edu.np

Chitra Bahadur Budhathoki is a professor of health education, Central Department of Education, Tribhuvan University, Kathmandu, Nepal. Interests of his research include teaching school health education, health and hygiene behavior of children and communities, and curriculum integration. His current research focuses on change in health and hygiene behavior of school children through participatory approaches. Email: cbbudhathoki@gmail.com

References

Acharya, K. P. (2016). Fostering critical thinking practices at primary science classrooms in Nepal. *Research in Pedagogy, 6*(2), 1-7. https://doi.org/10.17810/2015.30

Acharya, K. P. (2018). Hands-on, minds-on and hearts-on activities in high school science teaching: A comparison between public and private schools in Nepal. *The Online Journal of New Horizons in Education*, *8*(2), 51-57.

Acharya, K. P. (2019). Demystifying Science Teachers' Epistemic Belief on Chemical Concepts: Students' Engagement in the School Garden. Pedagogical Research, 4(4), 1-8. https://doi.org/10.29333/pr/5943

Acharya, K. P., Budhathoki, C. B., Bjønness, B., & Jolly, L. (2020). Policy Perspectives on Green School Guidelines: Connecting School Science with Gardens to Envision a Sustainable Future. *Journal of Sustainable Development*, *13*(3). https://doi.org/10.5539/jsd.v13n3p102

Armstrong, F., & Tsokova, D. (2019). *Action Research for Inclusive Education: Participation and Democracy in Teaching and Learning*. Routledge. https://doi.org/10.4324/9781351048361

Block, K., Gibbs, L., Staiger, P. K., Gold, L., Johnson, B., Macfarlane, S., & Townsend, M. (2012). Growing community: the impact of the Stephanie Alexander Kitchen Garden Program on the social and learning environment in primary schools. *Health Education & Behavior*, *39*(4), 419-432. https://doi.org/10.1177/1090198111422937

Bowker, R., & Tearle, P. (2007). Gardening as a learning environment: A study of children's perceptions and understanding of school gardens as part of an international project. *Learning Environments Research*, *10*(2), 83-100. https://doi.org/10.1007/s10984-007-9025-0

Brydon-Miller, M. (2018). *Critical learning, community, and engagement: elements for creating positive learning environments and opportunities for positive change*. https://doi.org/10.1080/09650792.2018.1469651

Carr, W., & Kemmis, S. (1986). *Becoming critical: Education, knowledge, and action research.* London, UK: The Falmer Press.

Denzin, N. K., & Lincoln, Y. S. (2008). *Collecting and interpreting qualitative materials* (Vol. 3). Sage.

Feldman, A., & Rowell, L. (2019). *Knowledge democracy and action research-an exchange*. https://doi.org/10.1080/09650792.2019.1618624

Fleming, M., Kenyon, L. O., Kenyon, L., & Upadhyay, B. (2015). Democratic science: Engaging middle school students in meaningful practices through community engagement. *Education in Democracy*, *7*, 37-63.

Greene, M. (1986). In search of a critical pedagogy. *Harvard Educational Review, 56*(4), 427-442. https://doi.org/10.17763/haer.56.4.010756lh36u16213

Greene, M. (1993). *Teacher as stranger*. Boston, MA: Wadsworth Publishing.

Habermas, J. (1987). *The Theory of Communicative Action: Volume 2: The Critique of Functionalist Reason*. Oxford: Polity.

Hearn, G., Swan, D., & Geels, K. (2019). Action research. In *The Palgrave Handbook of Methods for Media Policy Research* (pp. 121-139). Palgrave Macmillan, Cham. https://doi.org/10.1007/978-3-030-16065-4_7

Indraganti, M. (2018). Enquiry-based learning workshop for deep learning in Middle Eastern classrooms-an action research approach. *Educational Action Research, 26*(4), 603-625. https://doi.org/10.1080/09650792.2017.1379423

Jacobs, S. D. (2018). A history and analysis of the evolution of action and participatory action research. *The Canadian Journal of Action Research, 19*(3), 34-52.

Kafyulilo, A. C. (2018). Developing technological pedagogical content knowledge (TPACK) among pre-service science and mathematics teachers at DUCE: The role of activity-based learning. *Papers in Education and Development*, (31).

Kapoor, D. (2019). Research as knowledge democratization, mobilization and social action: pushing back on casteism in contexts of caste humiliation and social reproduction in schools in India. *Educational Action Research, 27*(1), 57-74. https://doi.org/10.1080/09650792.2018.1538894

Katsarou, E., & Sipitanos, K. (2019). Contemporary school knowledge democracy: possible meanings, promising perspectives and necessary prerequisites. *Educational Action Research, 27*(1), 108-124. https://doi.org/10.1080/09650792.2018.1564688

Kloser, M. (2013). Exploring high school biology students' engagement with more and less epistemologically considerate texts. *Journal of Research in Science Teaching*, *50*(10), 1232-1257. https://doi.org/10.1002/tea.21109

Laudonia et al., (2018). Action research in science education-an analytical review of the literature. *Educational Action Research, 26*(3), 480-495. https://doi.org/10.1080/09650792.2017.1358198

Lawton, M. (1997). Hands-on science gets a thumbs-up from students. *Education Week*, *24*(12), 373-421.

Lee, H., & Yang, J. E. (2019). Science teachers taking their first steps toward teaching socioscientific issues through collaborative action research. *Research in Science Education, 49*(1), 51-71. https://doi.org/10.1007/s11165-017-9614-6

Lewis, R. E., Herb, C., Mundy-Mccook, E., & Capps-Jenner, N. (2019). Lifescaping action research pedagogy. *Educational Action Research, 27*(1), 75-90. https://doi.org/10.1080/09650792.2018.1535446

Lorenzetti, L., & Walsh, C. A. (2014). Is There an 'F'in Your PAR? Understanding, teaching and doing action research. *The Canadian Journal of Action Research, 15*(1), 50-63.

Maibaum, L. (2017). "Advocating with Appreciative Inquiry." In *Lifescaping Practices in School Communities: Implementing Action Research and Appreciative Inquiry*, editor R.E. Lewis and P. Winkelman, 145-151. New York, NY: Routledge.

McNiff, J. (2016). *Writing up Your Action Research Project*. New York: Routledge https://doi.org/10.4324/9781315693620

Nyanjom, J. (2018). Cycles within cycles: instilling structure into a mentoring self-study action research project. *Educational Action Research, 26*(4), 626-640. https://doi.org/10.1080/09650792.2017.1386116

Otienoh, R. (2015). Conducting action research in Kenyan primary schools: A narrative of lived experiences. *The Canadian Journal of Action Research, 16*(1), 48-69.

Olitsky, S. (2007). Promoting student engagement in science: Interaction rituals and the pursuit of a community of practice. *Journal of Research in Science Teaching*, *44*(1), 33-56. https://doi.org/10.1002/tea.20128

Passy, R. (2014). School gardens: Teaching and learning outside the front door. *Education 3-13*, *42*(1), 23-38. https://doi.org/10.1080/03004279.2011.636371

Ping, W. (2015). Enhancing classroom participation of rural trainee teachers of English through use of action research: A reflection from a Chinese teacher trainer's perspective. *The Canadian Journal of Action Research, 16*(1), 31-47.

Robinson, E. T. (2018). Mapping Complexity in an Elementary Mathematics Classroom. *The Canadian Journal of Action Research, 19*(3), 5-33.

Rodriguez, M. T., Lamm, A. J., Odera, E., Owens, C., & Thompson, S. (2015). Evaluating Impacts of School-Based Extension Garden Programs from a Child's Perspective. *Journal of Extension*, *53*(1), n1.

Rowell, L. L., & Hong, E. (2017). Knowledge democracy and action research: Pathways for the twenty-first century. In The Palgrave international handbook of action research (pp. 63-83). Palgrave Macmillan, New York. https://doi.org/10.1057/978-1-137-40523-4_5

San Antonio, D. M. (2018). Collaborative action research to implement social-emotional learning in a rural elementary school: helping students become "little kids with big words. *The Canadian Journal of Action Research, 19*(2), 26-47.

Selim, M. A., & Shrigley, R. L. (1983). The group dynamics approach: A sociopsychological approach for testing the effect of discovery and expository teaching on the science achievement and attitude of young Egyptian students. *Journal of Research in Science Teaching*, *20*(3), 213-224. https://doi.org/10.1002/tea.3660200305

Seniuk Cicek, J., Ingram, S., Friesen, M., & Ruth, D. (2019). Action research: a methodology for transformative learning for a professor and his students in an engineering classroom. *European*

Journal of Engineering Education, 44(1-2), 49-70. https://doi.org/10.1080/03043797.2017.1405242

Somerset, S., Ball, R., Flett, M., & Geissman, R. (2005). School-based community gardens: Re-establishing healthy relationships with food. *Journal of the Home Economics Institute of Australia*, *12*(2), 25.

Tracy, S. J. (2019). *Qualitative research methods: Collecting evidence, crafting analysis, communicating impact*. John Wiley & Sons.

Vedder-Weiss, D., & Fortus, D. (2013). School, teacher, peers, and parents' goals emphases and adolescents' motivation to learn science in and out of school. *Journal of Research in Science Teaching*, *50*(8), 952-988. https://doi.org/10.1002/tea.21103

Watts, P. D., & Pajaro, M. G. (2014). Collaborative Philippine-Canadian action cycles for strategic international coastal eco-health. *The Canadian Journal of Action Research, 15*(1), 3-21.

Whalen, C. (2016). Participatory action research and paying it forward. *The Canadian Journal of Action Research, 17*(3), 1-2.

Worthen, M., Veale, A., McKay, S., & Wessells, M. (2019). The transformative and emancipatory potential of participatory evaluation: reflections from a participatory action research study with war-affected young mothers. *Oxford Development Studies, 47*(2), 154-170. https://doi.org/10.1080/13600818.2019.1584282

Appendix A: Gardening Science Curriculum Outline

THEMES	STUDENTS' ACTIVITIES
SCIENCE CURRICULA	Science curricula and sustainability, the local context for science learning. Sustainable agriculture at school and science learning. Dialogue conferences, workshops, and discussion on school gardening and science learning.
ACTIVITIES	Garden site selection, soil and compost preparation, seed preparation, and planting.
LEARNING SCIENCE	The pH of soil, filtration, decantation, sedimentation processes. Identify types of roots, leaves, and seeds. Soil types, their nature, and composition.

Appendix B: Garden-based School Science Curriculum, A Sample

COMPONENTS	DESCRIPTION	LEARNING OUTCOMES
CURRICULUM TITLE	Science curricula have different units linking science learning with gardening activities.	To explore science contents with school gardening activities.
UNDERSTANDING GOAL	Articulating a goal at the beginning of each unit for understanding.	To explore the types of flora and fauna in the garden of community schools.
PERFORMANCE TASK	The performance task is context-based in which each student discusses, observes, and plays in the garden.	To work together to create a model school garden to support science learning in the schools.
INFORMATION	This section provides background information on the content.	Understanding more about how gardening activities and growing vegetables are linked to the science curricula. This provides an alternative way to study science through activity-based instruction.
ACTIVITIES	These are suggested activities for use in delivering the content knowledge and skills necessary for students to accomplish their performance task and meet the understanding goal.	Visit the school garden as a classroom to observe, collect, and demonstrate to the students in the presence of teachers. And finally, link it to the science curriculum.

Appendix C: Activities and Learning Outcomes

SOIL TYPE	LEARNING OUTCOMES	ACTIVITIES
CLAY SOIL, **SANDY SOIL, SILT SOIL AND** **HUMUS**	To identify the types of soil on the basis of the size of soil particles. To identify humus content in the soil. To separate biodegradable and non-biodegradable solid wastes. To prepare compost manure by decomposing biodegradable materials.	Find soil pH, collect biodegradable materials in a pit, collect earthworms and put in the pit, mix compost manure in the soil, supply water, discuss, write-up, and present.

Appendix D: Curricular Outcomes and Activities

PLANT PARTS	LEARNING OUTCOMES	PLANT MATERIALS	ACTIVITIES
ROOT	To identify the types of roots. To collect types of roots and discuss.	Onion, garlic, radish, grass, rose, marigold, spinach, coriander leaves, tomato, short and long beans	Prepare soil, mix compost manure in the soil, prepare dams, collect types of plants, observe, discuss, write up, sketch, and present.
STEM	To explain the functions of the stem. To classify the types of the stem of dicot plants.		
LEAF	To describe the functions of a green leaf. To identify the types of plants on the basis of age. To collect different types of leaves and prepare herbarium.		
FLOWER	To recognize flowers as complete or incomplete. To observe the flower in the garden and draw its parts. To identify the types of flowers in the school garden.		
FRUIT	To identify the types of fruits from the school garden. To collect and eat fruits.		
SEED	To identify the types of seeds. To make a seed chart on paper and display on the wall. To germinate the seeds in the garden soil/glass and study radicle and plumule.		