Bridging informal and formal science learning through home gardening during covid-19: An experiential approach to environmental education

Appaji Nanda[1,2]*, Gungurumale L. Janardhana[1,3]

[1]Biodiversity Education and Research Lab, Environmental Study Centre, Opposite University of Agricultural and Horticultural Sciences, Kodachadri Integrated Development Society Rathnakaranagar, No 70/1, Shivamogga 577204, Karnataka, India

[2]Department of PG Studies and Research in Applied Botany, Bioscience Complex, Jnana Sahyadri, Kuvempu University, Shankarghatta, Shivamogga, 577451, Karnataka, India

[3]Elder's life Exhilaration Centre, Opposite University of Agricultural and Horticultural Sciences, Jnana Sagara Nave Trust ® Rathnakaranagar, Shivamogga 577204, Karnataka, India

*Corresponding author, email: nanda.biodiversity@gmail.com

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Abstract
Formal education is curriculum-oriented with less practical exposure or time limit to practice, informal learning is life skills learning education since childhood from their parents and society. The COVID-19 pandemic and school closures indicate a loss of formal education and learning deficiency, knowledge, and skill gaps, which are the universal challenges for every teacher, parent, and student. Hence the present study explores to understand the activities of the garden activities to connect with textbook concepts. We interacted with 8923 students of Lower primary school, Higher primary school, and High school and 24,255 family members. The collected data from the semi-structured questionnaire for the students and family responses were analyzed with descriptive and qualitative statistics. The findings revealed that the involvement was more with Lower primary school than Higher primary school and High school. The different classes of students, like the Lower primary school ($r_s = 0.85$, $p<0.003$) involvement ratio, have a higher significance than Higher primary school ($r_s = 0.72$, $p<0.05$) and High school ($r_s = 0.65$, $p<0.05$). The significant involvement of parents revealed that the father gave more exposure to the skills than the mother. Whereas High school students experience and gain more skill knowledge for the textbook content concept was ideal than Higher primary school and Lower primary school. Further research can be focused on studying the impact of pedagogical links with home gardening and farming skills serve as an effective module to connect informal learning with formal education, with a modification in education curriculum and policy.

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1. Introduction

Learning without skills itself is a disability in understanding core formal education which is very essential for the life skills hence our intervention with parents, teachers and students was an attempt to know where students with family are spending most of their time in gardening activities during COVID-19 holidays and their interest in learning and connecting with school subject concepts.

Students learning life skills and their performance is related to schooling and how the absence of schooling during the pandemic was least known but parents were more concerned about their learning, and understanding the core concepts of subjects we wanted to evaluate their time spent with their family members in the home garden as well as farming activities as they were the routine leisure time and how gardening correlated with their subject learning. Ecology and ecosystem in the surroundings we live breathe and enjoy our lifespan is least known in the present scenario. Most institutions, organizations, and universities have shown that their studies during COVID-19 are a failure in learning and might fail to know where actual learning begins. Home is the first school of learning, acting and independence. To support the education loss during the COVID-19 the United Nations Educational, Scientific and Cultural Organization (UNESCO 2020) planned for equity during the school closures (UNESCO 2020a), learning remained uninterrupted during the pandemic (UNESCO 2020b) and the responses of schools to COVID-19 and disruption (UNESCO 2020c).

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As (Umar, 2011), study indicates biological knowledge is not only about the collection of facts but is associated with human life and general theories. As they mentioned teachers are not the source of knowledge in the innovative teaching and learning process, it may be because of an untimely syllabus or curriculum and they might have failed the action-oriented (Bedemo, 2020).

As (Tayler, 2015), family member's role is important in developing their children's social and emotional skills to learn what is essential. Concept mapping promotes critical thinking supports more learning outcomes (Hsu & Chang, 2011) and creates connections between two or more concepts (Jack, 2013). Concept mapping is a descriptive and creative way of teaching a concept in an organized way to reflect the relationship among the content where students' responses to the topic and contents are easy to recognize and understand (Novak & Canas, 2006).

The knowledge gained by learning from biology has helped to solve human problems in the field of agriculture, health-related issues and animal husbandry, and hence biology is the most popular subject among students (Chu, 2008). Then how its benefits students in learning cores subject concepts during their school days was the need of hour to understand during the pandemic.

The educational content and the benefit of promoting children's field learning and development through everyday activities, which must be regular and practical, will benefit children in understanding the content rather than reading (Dunst et al. 2014). The complexity is due to the failure to understand the concepts (Ziegler & Montplaisir, 2014). The intensity and frequency of home learning with children and parent's engagement during the pandemic than before was more (Sonnenschein et al., 2021; Wheeler & Hill, 2021). The findings of (Kristy et al., 2023) reinforce the important role of parents in their children's early reading development particularly when the typical agents of instruction (i.e., teachers) have less time and opportunities to interact with their students because of the pandemic. The present study focuses on the perception of family members being together and sharing Gardening skills and how children have redefined their textbook contents. Research studies assert that the home learning environment for children's early learning and readiness for school (Fantuzzo et al. 2004; Melhuish et al. 2008). Family involvement with children's learning and parents are internationally regarded as children's first teachers (Niklas et al. 2016).

Apart from Children's everyday experiences, such as a playground, which is the source of many kinds of activity settings and provides different kinds of learning opportunities and experiences (Dunst et al. 2001). But in the present study, the practical exposure redefined the focus area because, from the present study, the experiential learning by students with parents, and they connected their learning with school subjects; hence, this work bridged the gap from the present area. Why have we (educational boards and parents) not yet considered our home garden or farming areas as one of the major informal institutions? How the COVID–2019 phobia was minimized by being in the Garden and what new things they learned are described based on hands-on experience in the present study to reveal all the experiences as a textbook subject.

Home garden and farmland a miniature of nature and gardening is an experiential learning of natural science discipline that allows everyone to learn life skills. How students who are involved in gardening learn some skills being with family members and when enquired about their actions and school subjects (formal education) they recalled their actions and linked them with their subject concepts (informal learning) and our intervention made us connect the formal and informal learning life skills and if allowed to practice these in the future as their practical exposure will support the students to learn theories and concepts by their actions (doing) and enjoying the subject concepts and remember it as their life skills for the future sustainable living style. Hence, we wanted to address the following questions based on experiential learning in the present study. We addressed research questions to know our involvement and understanding and how best the practices in learning should be made practical. We addressed the following research questions in this study to fulfill its main objectives

a. How garden activities support recalling/remembering the core school subject concepts?

b. How does family member's involvement support them in understanding the core concepts?

c. How home gardens and farming skills supported their experiential learning pre and pandemic days?

d. Do student's garden and farming skills vary before and during COVID-19?

2. Method

The present study was an attempt to engage children (students) and family members to overcome the first phobia of school closure, what is next in the academic future. The later phobia was COVID-19 symptoms; as a result, to connect people, family, and community with pedagogical activities we examined how informal learning

skill actions meet the goals of formal education (2019-2021). We interacted with 7 blocks of taluks of Shivamogga district. Karnataka (Figure 1).

With a preliminary interaction with teachers, parents and students and maximum time spent in the garden we made a questionnaire and involved parents and students of different grades from (1 to 10) standard.

2.1. Data collection

A semi-structured questionnaire for the students and family response was collected. Based on the participated students and parent's response the analysis was performed to meet desired basic objectives. The questionnaire served as the foundation for developing open-ended questions.

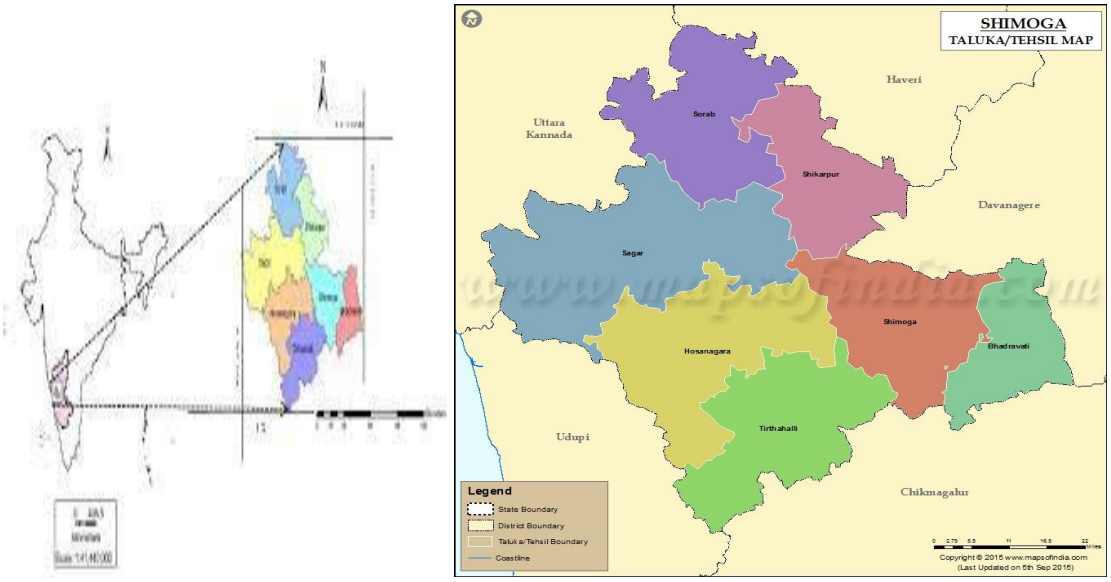

Figure 1. Map showing all the study areas of Shivamogga, Karnataka, India

2.2. Participants

The student involved in the study varies from Lower primary school (Lps – standard 1 to 4) 18.23%, Higher primary school (Hps – standard 5-8) 22.3%, and High school (Hs – standard 8 to 10) 59.2%. We interacted with 8923 students within the family members 24,255 including (mother, father, grandmother, grandfather, sisters, brothers, aunty, uncle, etc.) and found the interaction very informative. The involvement of high school students is maximum because family members can easily handle them in the garden for most of the activities followed by Hps and Lps. Lps and Hps students have shown interest but parents minimized their entry for most of the activities due to preventive measures. (Figure 2). Whereas the sex ratio indicates 68.55% of females and 31.44 % of males show their interest in learning, involvement, commitment and observation to learn more accepting failures, learning attitude, time management, and repetition of maximum activities have favored girls to fare well in the garden.

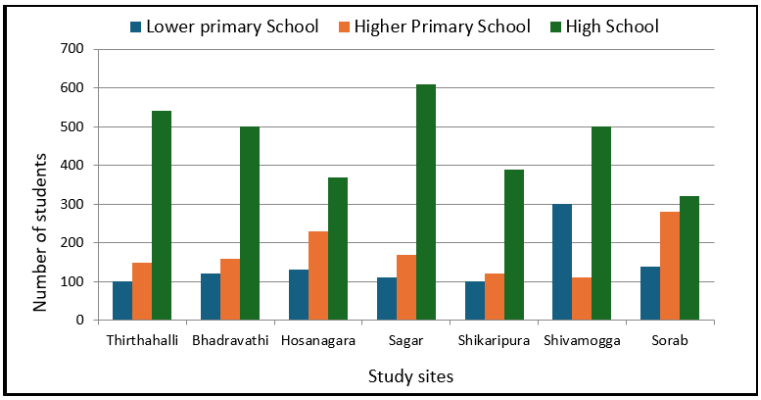

Figure 2. Different class-wise students from different study block sites.

2.3. Data Analysis

Descriptive statistics (mean, average and percentage) and Spearman's rank correlation (Zar, 2007) were performed to check the significance within the study limits within and between the groups (grades of students) different school subjects and family members involvement was checked in detail.

3. Results and Discussion

3.1. Concept map and the core subjects

The major learning of the present study as shown in the concept map (Figure 3) and how the subject concepts connected based on their education and understanding in the present study are described in (Table 1). The different classes of students like the Lps ($rs = 0.85$, $p<0.003$) involvement ratio have a higher significance, than Hps ($rs = 0.72$, $p<0.05$) and Hs ($rs = 0.65$, $p<0.05$). Lps student's interest in being involved in all the activities has shown more commitment than in other classes.

Table 1. The concepts and activities performed in the garden or farm land and their relation to core subjects

Activities	Concepts	Subjects
Gardening	Discipline, segregation, manuring, mulching, waste management, planting, weeding, maintenance and nurturing	Science, biology, value education, environmental study
Soil making	Grading soil quality, soil layer, soil type, soil color, soil porosity, soil management	Science, biology - microbes
Sowing	Seed health and handling, soaking, germination to sapling, handling sapling and percent of germination and sapling success, handling bunds (rows and column).	Science, mathematics
Handling equipment	Different names of equipment, handling and holding, purpose of equipment.	Science, kannada language, mathematics
Pruning	Quantity, size, shape, numbers, hygiene, health and handling	Science, social science and Mathematics
Cleaning equipment	Health, handling, water, maintenance, removing soil and dust from machines	Science, mathematics, physical education
Art of making bunds	Water use, soil erosion, water conservation, management.	Science, mathematics, physical education
Art of making garden	Diversity of plants, birds, insects, wealth and health of garden, and beauty of garden	Science, mathematics, physical education
Machine handling	Timing sense, handling, standing posture, concentration, health	Science, kannada language, mathematics, physical education
Plant disease	Hygiene, health and handling to minimize repellents, minimizing waste and management	Science, biology - microbes
Multiple names of plants / greens	Common or local name of plants and their uses as food, medicine and fodder	Languages, science and social science
Garden / farm as a miniature of forest	Activities performed repeatedly and getting chance to perform with a mentor and guidelines, participation and repetition of experiments	Core concepts of physics, chemistry, biology, mathematics, languages, and social sciences.
Area / space occupied	How to manage space within the garden (rows and columns)	Science, social science, geography, history
Plant growth	Osmosis, diffusion, photosynthesis,	Science, biology
Seasons	leaf life span, flowering duration, fruit availability, manuring time and duration	Science, geography
Role of mentor/family members and their commitment	Activities, involvement, mistakes, care, concentration, consciousness, repetition, reasoning the concept, questioning till the desired answer and satisfaction.	Remembering school subjects and teachers who taught different concepts and logic.

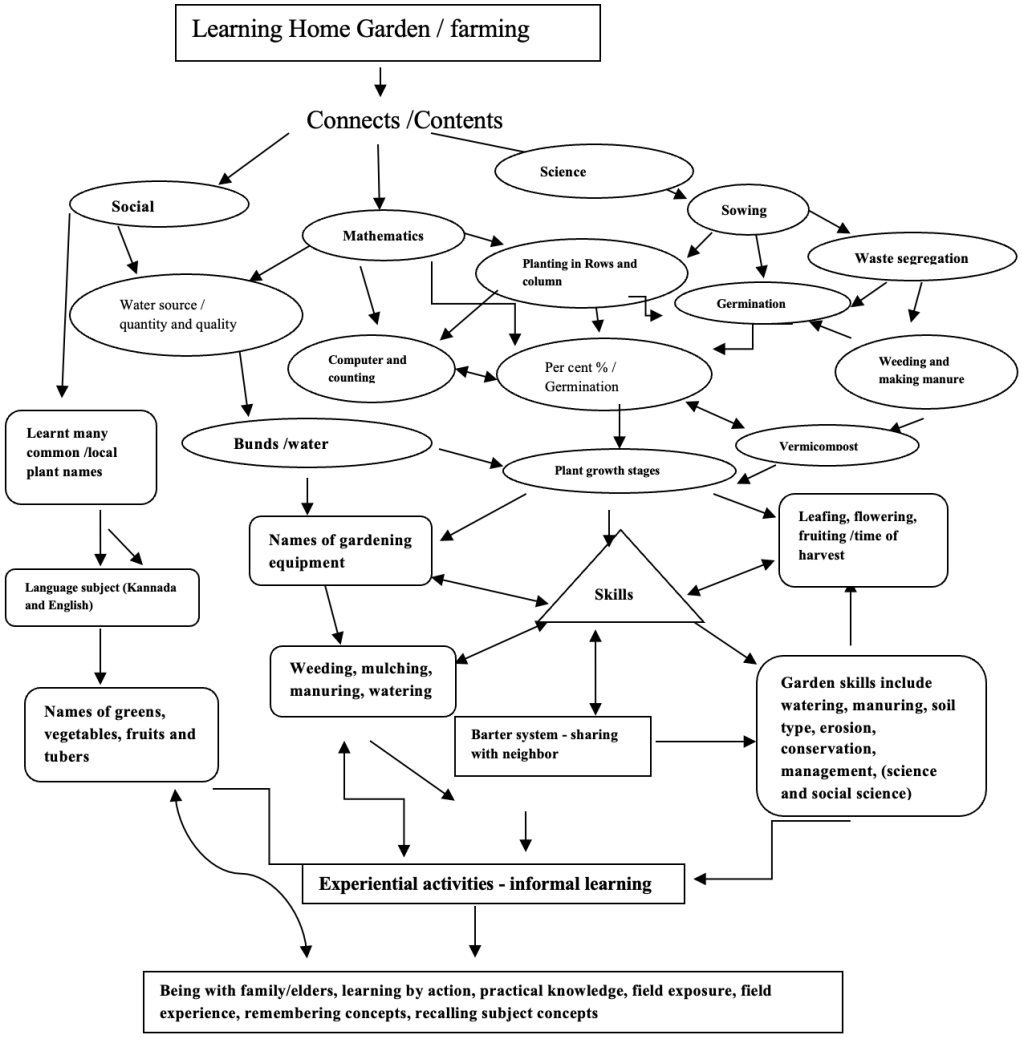

Figure 3. Home garden and farming skills with core subject concept mapping (source –author's elaboration)

3.2. Parents role in motivating informal teaching

Parents expressed their attempt to teach and familiarize some of the core subjects are science education and concepts ranks first followed by Horticulture skills, social studies, Kannada (language), Mathematics and Environmental studies. (Figure 4). Science education skills like seed soaking, germination, watering and absorption (osmosis and diffusion) photosynthesis and leafing size, color change shape etc. all were discussed with family members. Whereas in social studies like watering, excess water flow, soil erosion, bund making, soil and water conservation and management skills with activities. Water storage points like ponds, for utility and minimum usage during different stages of plant growth. In Kannada the different names of plants (many common/local names of plants and their use as food, fodder, medicine and manure), equipment used, manures name and nature connection with the songs and adage. In mathematics number of seeds sown in rows and columns, germination success (%), sapling plant success (%), watering time, manuring time, counting of seeds and watering period. In Environmental studies, segregation of waste, minimizing inputs, recycling, differences in degradable and biodegradable, renewable and non-renewable energy sources and its significance in garden and farming. Attempt to get exposed to the activity's Hs ($rs = 0.73$, $p<0.01$) students learned more subject concepts than Hps ($rs = 0.68$, $p<0.02$) and Ls ($rs = 0.52$, $p<0.03$) (Table 1). In gardening and farming activities father plays a major role and other family members are involved in the present study as shown in (Figure 5), followed by the mother, grandmother, elder brother, grandfather, elder sister, uncle, aunty and teachers. As the teacher's role in gardening and farming skills is last indicated in school these activities get minimum exposure and the time spent is less in school compared to home. The correlation of the father ($rs = 0.82$, $p<0.0005$) role is maximum followed by mother ($rs = 0.75$, $p<0.0004$), grandmother ($rs = 0.65$, $p<0.003$), grandfather ($rs = 0.54$, $p<0.004$), elder brother ($rs = 0.53$, $p<0.003$), elder sister ($rs = 0.45$, $p<0.002$) and teachers ($rs = 0.32$, $p<0.001$).

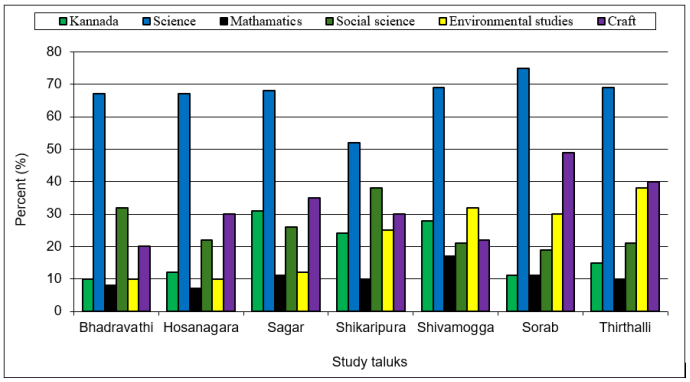

Figure 4. The per cent of students who learnt different core subject concepts

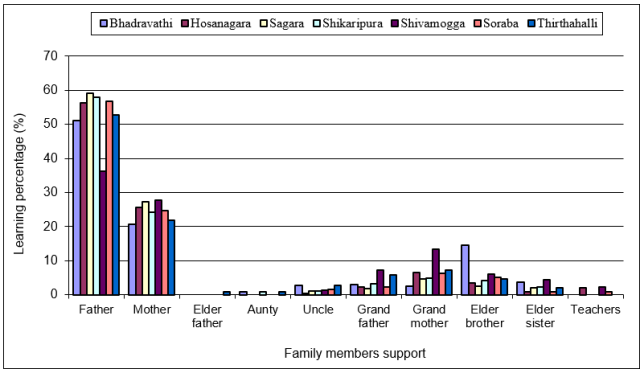

Figure 5. The per cent of parent's involvement in teaching the skills

3.3. Informal learning before and during COVID -19

The duration of time spent or exposure to the garden during COVID days is more than during the non-COVID period has a major impact on some of the skills students learnt (Figure 6). The correlation study reveals that Hs ($rs = 0.71$, $p<0.0001$) students are more educated followed by Hps ($rs = 0.65$, $p<0.0002$) and Lps ($rs = 0.52$, $p<0.03$). Apart from the subjects recalled the value education or moral education was evaluated like gardening discipline, involvement, commitment, observations, time spent, interest etc. The correlation study reveals that Hs ($rs = 0.72$, $p<0.0001$) students are more educated followed by Hps ($rs = 0.64$, $p<0.0002$) and Lps. ($rs = 0.55$, $p<0.03$). The activities, concept behind the activity and core subject remembered during the gardening reveal the importance of informal education and its significance within the family and community and how learning plays a pivotal role in bridging the gap.

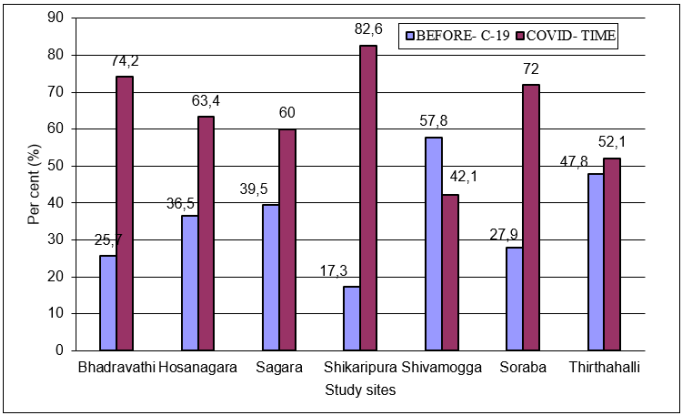

Figure 6. The per cent of students learning and involvement in garden and farming skills

The present study indicates how home activities have supported some student's learning during the pandemic. Based on the current study of research, we proposed using a relatively novel approach, to study children's family experiences and perceptions and their association with academic gaps.

3.4. Importance of gardening and text book content

We found the idea of garden activity and approaches to reach the textbook content have facilitated their way to reach the students. However, our study goes further to describe the compounding of differences and the consequences associated with long-term sizable disparities in involving them to feel the experiences. Our results also indicate that family and schooling experiences make a more balanced contribution to explaining certain simple skills and tools as stated by our research, while describing the importance of these experiences over the pandemic and subject contents, although children's overall levels of accumulated experiences did not fully explain gaps but being with family and community non-schooling time was balanced. In a few instances, they want to connect the school subject to day-to-day activities to feel their subject and content as much as possible. The findings of previous research documented that students learn during challenging times, including natural disasters (NAEP, 2022; Ward et al., 2008). The earlier studies during the pandemic appear to be negatively associated with young student's learning of inference-making because inference-making is a core general skill that can influence not only reading but also learning of different subject areas (Kendeou et al., 2020).

3.5. Gardening skills with different grades of students

However, in the present study, the Lower primary school student's interest was comparatively more than their counterpart. One study of modeling student's reading during the pandemic suggested that having parents read to their children every day would support the potential loss of reading ability gain (Bao et al., 2020). The present study also reveals same as children's experience is more accurate when being with parents in field activities. The present study revealed benefits for students for their experiential learning supported them in understanding subject core concepts with repeated actions every day with family members as their teachers as we have some consistent studies (Spitzer & Musslick, 2021), provide some clarification as to why some student's academic outcomes may have increased rather than decreased during the pandemic. Not all students are experiencing learning loss. However, some students are experiencing some level of learning loss, there were also instances where this was not the case. For example, Maldonado and De Witte (2020) as well as Kuhfeld et al., (2020) found learning losses in certain subjects but insignificant impacts in others. This is related to their level of grade and exposure to content and modules. Engzell et al., (2020) determined that losses were up to 60 percent larger amongst students from uneducated homes, but we found the reverse is true from the present study because farmer's families had a better experience than non-farming families but the parents failed to connect the concepts of the subject based on their field experience with a module due to lack of textbook subject concepts for them but student's manage to link with the core concepts of text books based on their experiential learning this observations of both parents and children's was remarkable from the present study (Figure 3).

3.6. Learning gardening skills with parents

As Coleman reports, the findings of researchers have shown that parents play a major role in education (Coleman et al., 1966), and today it is well established that parental effort makes a difference in educational outcomes and child well-being. Indeed, the majority of studies have predicted academic success when parents are actively involved in their children's educational process, either through their relationship with teachers and the school or their support of learning at home (Dearing et al., 2006; Flouri & Buchanan, 2004; Katz, et al., 2011; Walsh, 2010). Our research quantified some of the garden skills in (Table 1), activities and some concepts connected with their actions, which is reciprocal to Balli's (1998) study reveals students feel confident when they perform some exercises at home with their families they do better in school. The study (Janardhana & Nanda 2023) kitchen activities have played a greater impact based on their experiential learning during the COVID-19 holidays and their study revealed the kitchen as a laboratory to better understand subject concepts being with family members.

3.7. Gardening skills and future avenues in formal education

The present garden experiment exposure agrees with their study for experiential learning being with family and community. As green education is important because it promotes environmental conservation and sustainability (Adnyana et al., 2023). Educational research is very limited to know the impact of COVID-19 on students and family involvement in gardening skills to connect with subjects because the quality and quantity differ with the cultural and socio-economic, education and geography as student learning progress is limited in many areas. But in the present attempt, the children's being with family members learned maximum skills based on the duration of exposure and their practical and repeated filed exposure.

4. Conclusion

Major highlights, findings and understanding of the studies are students' acquisition of more skills is related to time spent in the garden, as children get exposed to the same queries and skills, hopefully compared to students whose exposure is minimal. We noticed that more gardening and farming skills if their parents have children to gain more skills compared to lesser skilled parents. It is related to more or less core concept understanding. The garden and farming area availability and number of plants in the garden and farm land are directly linked to more activities, more experiments, repetitions and more exposure. We found pandemic and school closures opened new avenues for learning and recalling, and remembering core subject concepts with

practical exposure, with a minimum investment. Students finally expressed the garden as a laboratory and a miniature of nature, and expected the same to trigger their motivation to adapt the same in school for a practical and skillful exposure in the future.

Author Contributions

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Declaration of Conflicting Interests

The author declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

References

Adnyana, I. M. D. M., Mahendra, K. A., & Raza, S. M. (2023). The importance of green education in primary, secondary and higher education: A review. *Journal of Environment and Sustainability Education*, *1* (2), 42-49. https://joease.id/index.php/joease/article/view/14

Balli, S. J. (1998). When mom and dad help: Student reflections on parent involvement with homework. *Journal of Research and Development in Education*, *31*(3), 142–146.

Bao, X., Qu, H., Zhang, R., & Hogan, T. P. (2020). Modeling reading ability gain in kindergarten children during COVID-19 school closures. *International Journal of Environmental Research and Public Health*, *17*(17), 6371. https://doi.org/10.3390/ijerph17176371

Chu, Y. C. (2008). *Learning difficulties in genetics and the development of related attitudes in Taiwanese junior high schools* [Doctoral dissertation, University of Glasgow]. http://theses.gla.ac.uk/168

Coleman, J. S., Campbell, E. Q., Hobson, C. J., McPartland, J., Mood, A. M., Weinfeld, F. D., & York, R. L. (1966). *Equality of educational opportunity* (Report No. OE-38001). U.S. Department of Health, Education, and Welfare, Office of Education. https://files.eric.ed.gov/fulltext/ED012275.pdf

Dearing, E., Kreider, H., Simpkins, S., & Weiss, H. B. (2006). Family involvement in school and low-income children's literacy: Longitudinal associations between and within families. *Journal of Educational Psychology*, *98*(4), 653–664. https://doi.org/10.1037/0022-0663.98.4.653

Dunn, K., Georgiou, G. K., Inoue, T., Savage, R., & Parrila, R. (2023). Home and school interventions aided at-risk students' literacy during COVID-19: A longitudinal analysis. *Reading and Writing*, *36*(2), 449–466. https://doi.org/10.1007/s11145-022-10354-7

Dunst, C. J., Bruder, M. B., Trivette, C. M., Hamby, D., Raab, M., & McLean, M. (2001). Characteristics and consequences of everyday natural learning opportunities. *Topics in Early Childhood Special Education*, *21*(2), 68–92. https://doi.org/10.1177/027112140102100202

Dunst, C. J., Trivette, C. M., & Raab, M. (2014). Everyday child language learning: Early intervention practices. *Infants & Young Children*, *27*(3), 207–219. https://doi.org/10.1097/IYC.0000000000000015

Engzell, P., Frey, A., & Verhagen, M. D. (2020). Learning inequality during the COVID-19 pandemic. *SocArXiv*. https://doi.org/10.31235/osf.io/ve4z7

Fantuzzo, J., McWayne, C., Perry, M. A., & Childs, S. (2004). Multiple dimensions of family involvement and their relations to behavioral and learning competencies for urban, low-income children. *School Psychology Review*, *33*(4), 467–480. https://doi.org/10.1080/02796015.2004.12086262

Flouri, E., & Buchanan, A. (2004). Early father's and mother's involvement and child's later educational outcomes. *British Journal of Educational Psychology*, *74*(2), 141–153.

Hsu, C., & Chang, I. (2011). The relationship between computer-based concept mapping and creative performance. *Asian Journal of Arts and Sciences, 2*(1), 16–36.

Jack, G. U. (2013). Concept mapping and guided inquiry as effective techniques for teaching difficult concepts in chemistry: Effect on students' academic achievement. *Journal of Education and Practice, 4*(5), 9–16.

Janardhana, G. L., & Nanda, A. (2023). Kitchen activities and hands-on experience during lockdown COVID-19, informal to formal education core subject concepts: An empirical study, Karnataka, India. *Asian Journal of Education and Social Studies*, *49*(3), 137–150. https://doi.org/10.9734/ajess/2023/v49i31142

Kendeou, P., McMaster, K., Butterfuss, R., Kim, J., Bresina, B., & Wagner, K. (2020). The Inferential Language Comprehension (iLC) Framework. *Topics in Cognitive Science*, *12*(1), 256–273. https://doi.org/10.1111/tops.12401

Kuhfeld, M., Soland, J., Tarasawa, B., Johnson, A., Ruzek, E., & Liu, J. (2020). Projecting the potential impact of COVID-19 school closures on academic achievement. *Educational Researcher*, *49*(8), 549–565. https://doi.org/10.3102/0013189X20965918

Maldonado, J. E., & De Witte, K. (2020). The effect of school closures on standardized student test outcomes. *KU Leuven – Faculty of Economics and Business*. https://feb.kuleuven.be/research/economics/ces/documents/DPS/2020/dps2017

Melhuish, E., Phan, M., Sylva, K., Sammons, P., Siraj-Blatchford, I., & Taggart, B. (2008). Effects of the home learning environment and preschool center experience upon literacy and numeracy development in early primary school. *Journal of Social Issues*, *64*(1), 95–114. https://doi.org/10.1111/j.1540-4560.2008.00550.x

Vansteenkiste, M., Simons, J., Lens, W., Sheldon, K. M., & Deci, E. L. (2004). Motivating learning, performance, and persistence: The synergistic effects of intrinsic goal contents and autonomy-supportive contexts. *Journal of Personality and Social Psychology*, *87*(2), 246–260. https://doi.org/10.1037/0022-3514.87.2.246

National Center for Education Statistics. (2022). *Reading and mathematics scores declined during COVID-19 pandemic*. The Nation's Report Card. https://www.nationsreportcard.gov/highlights/ltt/2022

Niklas, F., Cohrssen, C., & Tayler, C. (2016). Parents supporting learning: A non-intensive intervention supporting literacy and numeracy in the home learning environment. *International Journal of Early Years Education, 24*(2), 121–142. https://doi.org/10.1080/09669760.2016.1155147

Novak, J. D., & Cañas, A. J. (2006). *The theory underlying concept maps and how to construct them*. Institute for Human and Machine Cognition. https://cmap.ihmc.us/publications/researchpapers/theoryunderlyingconceptmaps.pdf

Sonnenschein, S., Stites, M., & Ross, A. (2021). Home learning environments for young children in the U.S. during COVID-19. *Early Education and Development, 32*(6), 794–811. https://doi.org/10.1080/10409289.2021.1943282

Spitzer, M. W. H., & Musslick, S. (2021). Academic performance of K-12 students in an online-learning environment for mathematics increased during the shutdown of schools in wake of the COVID-19 pandemic. *PLOS ONE, 16*(8), e0255629. https://doi.org/10.1371/journal.pone.0255629

Tayler, C. (2015). Learning in early childhood: Experiences, relationships and "learning to be." *European Journal of Education, 50*(2), 160–174. https://doi.org/10.1111/ejed.12117

Umar, A. A. (2011). Effects of biology practical activities on students' process skill acquisition in Minna, Niger State, Nigeria. *Journal of Science, Technology, Mathematics and Education, 7*(2), 118–126.

UNESCO. (2020). *UNESCO's support: Educational response to COVID-19*. https://www.unesco.org/en/covid-19/education-response/initiatives

UNESCO. (2020a). *10 recommendations to ensure that learning remains uninterrupted*. https://en.unesco.org/news/covid-19-10-recommendations-plan-distance-learning-solutions

UNESCO. (2020b). *COVID-19 educational disruption and response*. https://en.unesco.org/covid19/educationresponse

UNESCO. (2020c). *Three ways to plan for equity during the school closures*. https://gemreportunesco.wordpress.com/2020/03/25/three-ways-to-plan-for-equity-during-the-coronavirus-school-closures/

Walsh, P. (2010). Is parental involvement lower at larger schools? *Economics of Education Review, 29*(5), 959–970. https://doi.org/10.1016/j.econedurev.2010.03.005

Ward, M. E., Shelley, K., Kaase, K., & Pane, J. F. (2008). Hurricane Katrina: A longitudinal study of the achievement and behavior of displaced students. *Journal of Education for Students Placed at Risk, 13*(2–3), 297–317. https://doi.org/10.1080/10824660802350143

Wheeler, D. L., & Hill, J. C. (2021). The impact of COVID-19 on early childhood reading practices. *Journal of Early Childhood Literacy, 22*(3), 408–431. https://doi.org/10.1177/14687984211044187

Zar, J. H. (2007). *Biostatistical analysis* (4th ed.). Prentice-Hall.

Ziegler, B., & Montplaisir, L. (2014). Student perceived and determined knowledge of biology concepts in an upper-level biology course. *CBE-Life Sciences Education, 13*(2), 322–330. https://doi.org/10.1187/cbe.13-09-0175