Cognitive Dimension of Learning Using Garden-Based Education towards Sustainability: A Meta-Synthesis

Jennifer D. Paño[1], Jeralden R. Jumao-as[2], and Marchee T. Picardal[3]*

[1,2,3]Cebu Normal University, Cebu City, Philippines

[1]https://orcid.org/0000-0001-6739-6386, [2]https://orcid.org/0000-0002-0775-6519,

[3]https://orcid.org/0000-0002-7257-6776

*Email Correspondence: picardalm@cnu.edu.ph

Abstract

Garden-based education (GBE) is an innovative approach to enhancing learners' academic performance. However, the mechanism of how it develops the cognitive domain of learning is unclear. This meta-synthesis of 22 published articles focusing on garden-based education integration in the educative process examined its impact on mental aspects of learning. Secondary data from each reviewed article were extracted and analyzed thematically. Five themes emerged describing the impact of GBE on the cognitive domain of learning, namely, 1) experiential learning, 2) meaningful learning, 3) explicit and implicit learning, 4) discovery learning, and 5) transmissible learning. GBE is a successful program in most of the basic education curriculum integration contributing to the improvement of academic performance. Albeit, there is no standard template for its implementation as it varies across context and educational system, adopting the general principle of school garden learning in the teaching and learning process is beneficial for sustainable learning outcomes.

Keywords: Garden-based education, curricular integration, Education for Sustainable Development (ESD), Meta-synthesis

1.0 Introduction

Garden-based education (GBE) is an innovative strategy to nurture the cognitive dimension of learning for sustainability. It highlights hands-on learning through plant cultivation and management. It is among the most effective ways to help learners achieve their development and connection with nature (Kim et al., 2020). The increasing interest in plants and gardening occurred at the onset of the pandemic, eventually coined the "plantdemic". The global health crisis increased the demand for greenery among Filipinos to overcome stress and relieve the impacts of lockdown. This trend of using learning gardens strengthens experiential learning with nature and connects learners to the most challenging societal problem such as climate change or environmental-related issues (Dunkley, 2016). GBE promotes botanical literacies among early childhood students (Beasley et al., 2021). One of the intended outcomes of this experiential learning is the improved academic performance of secondary students with challenging behaviors (Ruiz-Gallardo et al., 2013) and promoting greater interest and participation among students (Burt et al., 2018) in general. At the tertiary level, Eugenio-Gozalbo, Aragon, and Ortega-Cubero (2020) examined the integration of GBE in Spain as part of the innovative learning context for Teacher Training Institutions. They concluded that GBE improved student learning outcomes. Similarly, Eugenio-Gozalbo, Pérez-López, and Tójar-Hurtado (2020) affirmed positive science learning from basic education to the university stages. Cognizant of the role of GBE as a valuable educational resource offering cognitive benefits in most countries that integrated GBE into the basic education curriculum (Bailey & Falk, 2016; Cheang et al., 2017; Cross & Kahn, 2018; Fifolt & Morgan, 2019; Lehnerd et al. 2019; McMillen et al., 2019), synthesizing these articles offers insights on how this program can serve as a basis for the integration of GBE into the curriculum.

In the Philippine context, a DepEd Memorandum 293, Series of 2007 mandates the establishment of "*Gulayan sa Paaralan Program*" or school garden in public elementary and secondary schools nationwide to address malnutrition, food security, and promote healthy consumption of fruits and vegetables. Unfortunately, there is a paucity of data as to how this program is translated into the formal curriculum neither its integration into the discipline-based lessons such as science, mathematics, and the likes. Thus, the necessity of having GBE become a part of a larger educational plan/program or garden curriculum and the need to equip future teachers with gardening skills is deemed necessary. To support such a call for reform, there has to be evidence on how such integration promotes the cognitive domain of learning. This meta-synthesis intends to add depth and meaning to the results and interpretation of several studies (Brion & Cordeiro, 2018; Kim et al., 2020) examining the integration of GBE in different parts of the world.

Moreover, it has been a dominant observation among school garden programs that they concentrate more on improving learners' behaviour and knowledge towards food, inadvertently missing other opportunities to support learners' development (Murukami et al., 2017). Considering that gardening is part of the basic education program, teachers are expected to possess the knowledge and skills to teach it to the learners. However, several studies revealed that teachers participating in this school-garden learning lacked the technical knowledge to design effective learning activities using the school garden (Burt et al., 2018; Laaksoharju et al., 2012). This scenario necessitates the need to gather empirical evidence from current literature on the extent and benefits of implementation of GBE in the curriculum, at least at the cognitive level, to make an informed recommendation on possible curricular enhancement across educational levels.

2.0 Methods

Research Design

This study employed meta-synthesis for qualitative study. It is the systematic review and integration of findings from qualitative studies of a particular phenomenon of interest (Chrastina, 2018). The protocol adheres to the Combined Model containing the seven meta-synthetic stages by Chrastina (2018) as follows:

Step 1. - Deciding the phenomenon of interest - This meta-synthesis contributed to the present state of knowledge by filling a research gap and developing a conceptual model for Garden-based education.

Step 2. Deciding what is relevant- A combination of narrow and large comprehensive search strategies was employed using numerous databases and meta-search engines. The manuscripts were obtained via reputable academic electronic repositories using several search engines such as Crossreference, Scopus, ScienceDirect, JSTOR, Google Scholar, ERIC, Pro-Quest, Research Gate, and Gale Academy. Hand searching was also used for Google Scholar and Research Gate to check on the abstract and possible retrieval of the full text. The following information for inclusion (e.g., the context of the investigation, the availability of full papers, and the total number of papers) was decided through data saturation. Keywords search used Boolean operators for four different clusters of keywords, along with inclusion and exclusion criteria. There was no limit on how many studies might be included in order to make the results as saturated and transferable as feasible.

Step 3. Careful reading and re-reading - repeated reading of each journal was done to explore whether the inclusion and exclusion criteria were met and to assess the methodological and significant strengths and weaknesses. Key concepts were extracted from various journals to extract fundamental knowledge and compare their findings to establish a common understanding of GBE. Second-order constructs were recognized as the original writers' primary themes, whereas first-order constructs were identified as the individual participants' quotes. The master themes are the third-order constructions, and they represent the researchers' perspective.

Step 4. Determining the relatedness of the study - Once themes have been established and organized, a rigorous process of searching for connections between them took place. Thematic analysis approach by Braun and Clarke (2006) was then applied (Figure 1). Identification of qualified research journals was based on the Critical Appraisal Skills Programme (CASP) checklist using a three-point scale (Lachal et al, 2017).

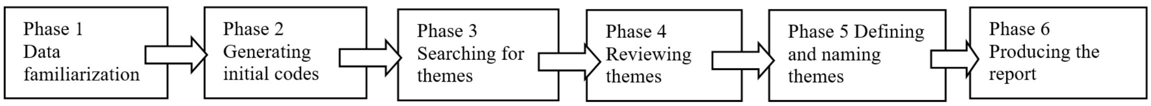

Figure 1. *Thematic Analysis approach*

The two authors used the Atlas.ti v7.0 software to conduct data analyses as suggested by Friese (2015). Data were then coded in the first stage, the descriptive phase, grouping the text into topic categories and allowing researchers to evaluate each statement independently and assess the possible contributions to the data meanings (Miles et al., 2014).

Open coding has been used, which entailed searching for content categories that had already been determined to be appropriate for the purpose of this research (Cohen et al., 2011). Inductive methods are common in qualitative research that gathers data to "rebuild" reality as depicted by the actors in a given social system. Researchers concurred on the concept of first-order codes (subcategories) and subsequently grouped them into a smaller number of second-constructs (categories). Finally, five categories emerged based on their numeric representation and substantial meaning for further analysis.

Relationships between individual themes were sought in the second stage, the interpretative phase, because they allow signals of contextual factors to be revealed and aid in understanding of the Garden-based education (Contreras, 2011). As a result, co-occurrence analyses were carried out on the five categories chosen, revealing the relationships between categories and subcategories. The relationships with the highest number of co-occurrences were deemed the most representative and were chosen to be displayed using explanatory visuals, as is customary (Miles et al., 2014).

Step 5. Translating studies into one another - the careful analysis of the themes employed the synthesis of argument lines wherein research identified several parts of an issue that can be combined into a new interpretation.

Step 6. Synthesizing the translation - In order to construct a conceptual model of the phenomena, all the themes that came up with the line of argument (synthesis) reflecting the entire category were mapped together.

Step 7. Communicating the results through publication.

Inclusion criteria:(1) the research design is qualitative; (2) the journal is academic and peer-reviewed; (3) the article is about garden-based education and its setting and/or similar experiences (4) the study used primary data; (5) The study's authors used a specified sample/ sampling; (6) qualitative data was collected using some well-known qualitative method(s); and (7) the paper was written in English.

Exclusion criteria:(1) studies with no research design and an entirely conceptual or theoretical background; (2) studies that use a quantitative method (quantitative-based research analysis); (3) studies that use closed-ended survey questions as the data collection tool; (4) qualitative data that is not organized into themes or study findings that do not reflect the GBE experience; (5) Mixed-method research in which qualitative and quantitative data could not be separated; and (6) qualitative studies on GBE that examines the effect or impact to the larger community or society as this study aimed to focus at the school level implementation only.

Search Result

There were eight search engines utilized in this study that were either through database search or through hand search (Figure 1). The original number of articles was 181,272; however, titles were vetted for the inclusion of terms in the search parameters, and this resulted to 476. The duplicated studies were deleted through continuous examination, resulting in 355. The abstracts of each publication were reviewed for the key - points sought in this study, decreasing the number of journals to 194. All qualified abstracts were then examined to see if the entire manuscript was available in English, yielding to 177 journals. Each article's methodology must be accurate and rigorous, to be qualified; this resulted in 35 studies. Finally, journals were evaluated using a three-point scale on the Critical Appraisal Skills Programme (CASP) checklist, yielding 20 qualified journals (Lachal et al, 2017).

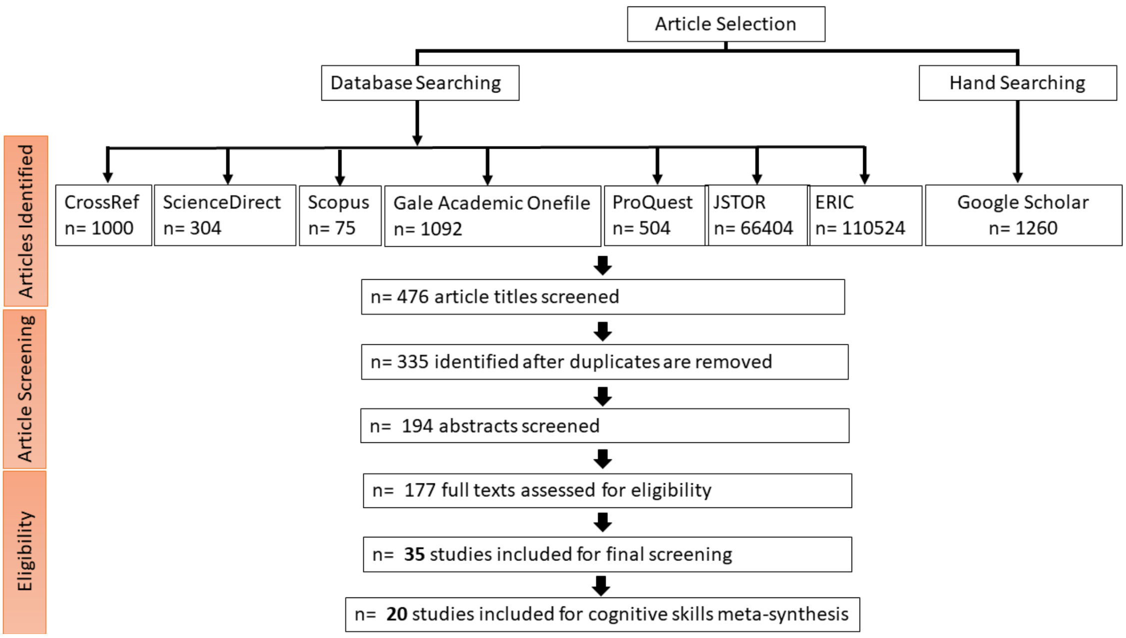

Figure 2. *PRISMA Flow Diagram for selecting studies*

3.0 Results and Discussion

The breakdown of the origins of the 20 studies included research journal publications from Asia (3), North America (14), Africa (1), and Europe (2), sourced from eight search engines. This meta-synthesis yielded five (5) key themes describing the cognitive skills learned by the students using garden-based learning. Table 1 provides an overview and characterization of the final themes.

For co-occurrence analysis, first-order codes were grouped together to their respective categories taking into consideration their quantitative weight (number of quotes) and contribution to the study goals. There were a total of 292 quotes or text fragments categorized as units, with 22 subcategories. Table 2 shows the reorganized subcategories.

Table 1. *Summary Table of First-order codes and quotation count*

Paper Code	Author of the Paper	First-order Codes (subcategories)	Quotation Count
2	(Laaksoharju et al., 2012)	Learning Work ethics Equality in the share of harvest Fun-play relationship Ability to read the environment Solve problems together	7
3	(Kangas et al., 2014)	Individual and Mutual Accountability Ownership of Learning Equality in the share of harvest Shared responsibility understanding of content knowledge Solve problems together Transmissible learning Connects Content and Context Learning Work ethics Meaningful engagements	23
5	(Kim et al., 2020)	Multi-sensory engagement Meaningful engagements Ownership of Learning Solve problems together Connects Content and Context Ability to read the environment Garden as site for inquisitiveness Tested knowledge of seed growing and transplanting Learning Work ethics Fun-play relationship	20
6	(Eugenio-Gozalbo, Aragon, & Ortega-Cubero, 2020)	Food-systems knowledge Agro-ecological experiences Connects Content and Context Transformational education Individual and Mutual Accountability Shared responsibility Solve problems together Learning Work ethics Transmissible learning	21

Continued on next page

Table 1. Summary Table of First-order codes and quotation count (Continued)

Paper Code	Author of the Paper	First-order Codes (subcategories)	Quotation Count
7	(Cramer et al., 2019)	Agro-ecological experiences Food-systems knowledge Fun-play relationship Garden as site for inquisitiveness Transformational education Transmissible learning Learning Work ethics Connects Content and Context understanding of content knowledge Ability to read the environment Meaningful engagements	35
8	(Greer et al., 2019)	Tested knowledge of seed growing and transplanting Agro-ecological experiences Fun-play relationship Garden as site for inquisitiveness Equality in the share of harvest Connects Content and Context Transformational education Food-systems knowledge Transmissible learning Community-building Complex level of Comprehension understanding of content knowledge	25
9	(Murakami et al., 2017)	Meaningful engagements Multi-sensory engagement Community-building Ability to read the environment Garden as site for inquisitiveness Transmissible learning Fun-play relationship Agro-ecological experiences Connects Content and Context understanding of content knowledge	22
10	(Cheang et al., 2017)	Agro-ecological experiences Ability to read the environment Transformational education Garden as site for inquisitiveness	12
11	(Schneller et al., 2015)	Connects Content and Context Ability to read the environment Transformational education Transmissible learning Meaningful engagements Food-systems knowledge Garden as site for inquisitiveness Collateral learning	26
12	(Cross & Kahn, 2018)	Ability to read the environment Agro-ecological experiences	2

Continued on next page

Table 1. Summary Table of First-order codes and quotation count (Continued)

Paper Code	Author of the Paper	First-order Codes (subcategories)	Quotation Count
13	(McMillen et al., 2019)	Ability to read the environment Tested knowledge of seed growing and transplanting Agro-ecological experiences Shared responsibility Complex level of Comprehension Food-systems knowledge Learning Work ethics Fun-play relationship	14
14	(Christodoulou & Korfiatis, 2018)	Transformational education Solve problems together Community-building Fun-play relationship Agro-ecological experiences Ability to read the environment Food-systems knowledge Transmissible learning	8
15	(Bailey & Falk, 2016)	Agro-ecological experiences Ability to read the environment Tested knowledge of seed growing and transplanting Community-building	8
16	(Davis & Brann, 2017)	Food-systems knowledge Agro-ecological experiences Connects Content and Context Transformational education	8
17	(Dickey et al., 2020)	Agro-ecological experiences Community-building Transmissible learning Transformational education	7
18	(Carlsson et al., 2016)	Agro-ecological experiences Food-systems knowledge Transformational education Complex level of Comprehension Garden as site for inquisitiveness Community-building	9
31	(Rich & Ardoin, 2014)	Agro-ecological experiences Transmissible learning Complex level of Comprehension Connects Content and Context Ability to read the environment Garden as site for inquisitiveness Transformational education Shared responsibility Food-systems knowledge	18
32	(Jorgenson, 2013)	Complex level of comprehension Ability to read the environment Garden as site for inquisitiveness	8

Continued on next page

Table 1. Summary Table of First-order codes and quotation count (Continued)

Paper Code	Author of the Paper	First-order Codes (subcategories)	Quotation Count
33	(Jones et al., 2012)	Meaningful engagements Connects Content and Context Agro-ecological experiences Transformational education Individual and Mutual Accountability Complex level of Comprehension Transmissible learning Ownership of Learning	16
34	(Acharya, 2019)	Garden as site for inquisitiveness Fun-play relationship	3
		Total Quotes	**292**

Table 2. *List of Themes, sub-themes, and number of codes*

Categories/ Sub-themes	Grounded Code
Theme 1: Experiential Learning	
1. Concrete idea of the lesson	11
2. Complex level of Comprehension	8
3. Active engagement in problem solving	9
4. Support learning on nature	6
Theme 2: Meaningful Learning	
5. Multi-sensory engagement	6
6. Students' meaningful engagement in planting	8
7. Ability to adapt to changing situations	2
8. Fun-play relationships	14
Theme 3: Explicit and implicit learning	
9. Food-systems knowledge	22
10. Sustainable food processes	10
11. Creative food production	5
12. Engagement on food production	6
Theme 4: Discovery learning	
13. Equality in the share of harvest	3
14. Garden as a site for inquisitiveness	17
15. Solve problems together	9
16. Ownership of Learning	5
17. Learning work Ethics	6

Continued on next page

Table 2. List of Themes, sub-themes, and number of codes (Continued)

Categories/ Sub-themes	Grounded Code
Theme 5: Transmissible learning	
18. Intergenerational learning	5
19. Collateral Learning	20
20. Shared responsibility	10
21. Individual and Mutual Accountability	10
22. Transformational Education	27

After co-occurrence analysis, five themes emerged. These include the following: experiential learning, meaningful learning, explicit and implicit learning, discovery learning, and transmissible learning.

Cognitive Learning in Garden-Based Education

Cognitive learning is the springboard for higher-order thinking, which helps students to remember, reason, solve problems, think, and learn, judge and reason. Five themes were presented to highlight the kinds of the cognitive impact of GBE, gleaned from the synthesized articles.

Theme 1: Experiential learning

Experiential learning is acquired when students are engaged in multisensory, cooperative, and collaborative engagement. Students perceive their lessons as tangible as they explore in the garden. It is where they learned the value of involvement in gardening as they plant and eat their grown food. The garden also enhanced their learning experience as they played the roles of problem solvers and community members while growing and caring for plants. The majority of the participants expressed their experiences in the following vignettes:

The concrete idea of the lesson

"Being able to participate in managing a garden, planting it and then harvesting it, will give them a better idea of things when they learn about photosynthesis, plant growth, life cycles, and things like that" (Article 8, Principal).

Complex level of Comprehension

One teacher commented that [the students] plant [the food] and they watch it grow and they look after it and they see that …they are not putting things on it that are not friendly to the things that grow (i.e., pesticides). I think that is important, and I think that is going to get way more and more and more important too (Article 18, SEF 91).

Active engagement in problem solving

"The children made inferences about the reasons for some seeds not sprouting and the ideal conditions for germination" (Article 5, teacher's observation).

Support Learning on Nature

"We take the children to the garden and let them experience firsthand what is healthy food" (First-grade teacher (5FG), Article 29).

The vignettes are evidence of how learned theories are connected to the real-life scenario as personally witnessed by the students. Their experiences in the garden stimulate critical thinking, nurture responsibility, evoke ecological provocations, and concretize knowledge about plants. Mohamed and Othman (2018) affirm these observations that School gardens cover a plethora of learning possibilities, as well as a natural laboratory for honing cognitive skills while gaining a greater understanding of nature.

Theme 2: Meaningful learning

A theory of cognition and learning states that a combination of previous organized cognitive structure and new learning experience results in meaningful learning (Ertmer & Newby, 2013). When students' recently acquired knowledge is combined with existing experiences and knowledge that generates a unique and personal comprehension that encourages meaningful learning (Acharya, 2019). These are concepts that are fully understood by learners and are of high value to their lives. Example vignettes that follow these findings are listed below.

Multi-sensory engagement

"Okay, I picked that one because I like how the children can touch smell, see the plants can notice the different heights of them as they grow; one child looks like they found a seed or some type of little critter, so that's why I picked it and they're all working together and also looking at things individually." —Terri, Year 1 (Article 9)

First-grader who ate a peppermint leaf said, *"This leaf tastes like Cinnamon Toast Crunch,"* (Student, Article 7).

Students' meaningful engagement in planting

"Being able to participate in managing a garden, planting it, and then harvesting it, will give them a better idea of things when they learn about photosynthesis, plant growth, life cycles, and things like that" (Article 8, Principal).

Ability to adapt to changing situations

"And I don't know whether that's simply knowing where it came from. It is less mysterious maybe? […] where did this come from when it appears on their plan, vs in the garden, […], this is where it came from. This is what it is. […] Just how willing they are to try new things in the garden" (Article 9, Cheryl, Year 2).

Fun-Play Relationships

"The kids right now just don't get a chance to play outside. When you use the outdoor classroom, they are not only getting their learning, but they're also getting that opportunity to play outside and get fresh air" (Article 23).

Students were delighted to learn about garden realities. For instance, underground potatoes and flowers require pollination to develop fruit. School garden learning bridges abstract concepts and real-life examples. This is exemplified when students' prior experiences and their lessons become relevant making any classroom dynamic and interesting. Similar to the findings of Cheang et al. (2017), a garden invigorates engagement by highlighting authentic and real-life organisms. The student's ability to perceive phenomena, analyze their observations, and creatively inquire about the experience is enhanced by direct interaction with natural growth processes and development in a garden. Hence, activities using multi-sensorial approaches, hands-on experiences, and a garden as a living laboratory may enhance students' focus and ability to learn and develop inquisitive minds and critical thinking.

Theme 3: Explicit and implicit learning

Explicit learning is the information acquired by the learners directly while implicit learning is the complex information acquired incidentally. Explicit learning includes identifying what to plant and the elements needed to make a garden grow. It also includes where food comes from and how it grows. Implicit learning is manifested by food-system knowledge, pea growing and counting while in the garden. It also pertains to the family knowledge of gardening and cooking, allotting space for self-exploration, and a deeper understanding of scientific processes to make better choices, seed cultivation, and follow-up. Some of the respondents affirmed implicit and explicit learning in the following vignettes:

Food-systems knowledge
"Okay, I picked that one because I like how the children can touch smell, see the plants can notice the different heights of them as they grow and one child looks like they found a seed or some type of little critter, so that's why I picked it and they're all working together and also looking at things individually." —Terri, Year 1 (Article 9)

Sustainable Food Processes
"My whole life we've gotten local or organic foods, but I never knew really why. I didn't know about the conventional and organic and local food, and the differences between them ... that was a helpful lesson for later in life" (Student, Article 10).

Creative Food Production
"Another teacher added that in her visits to the garden, she is teaching the students to recognize the connection between the health of the soil to that of the plants and then 'how we're going to benefit from this plant" (Teacher, SEF 9, Article 28).

Engagement on food production
"We had several children… their parents said that they refused to eat broccoli. And when… they helped us harvest the broccoli. And when we cut it up and had it for snack … they all tried it. And some of the children … went home and told their parents that they like it … I think that the reason why they tried it was because … they put in so much hard work in gardening and weeding and taking care of them" (Article 23).

The school garden is considered a valuable avenue for teacher training institutions since it has a wide array of knowledge sources. Eugenio-Gozalbo, Aragon, and Ortega-Cubero (2020) supports this contention in their observation that gardening provides better context for science instruction as it stimulates interest and motivation to learn.

Theme 4: Discovery learning

Discovery learning encourages students to learn at their own phase by motivating students to ask their questions and formulate tentative answers. Based on the nuances of participants in the study, discovery learning is exhibited in students' interest in eco-garden management and hands-on activities. Some accounts from the participants revealed that:

Equality in the share of harvest
"Children were very precise in sharing the harvest fairly" (Teacher's observation, Article 1).

The garden as a site for inquisitiveness
*"And I'm really into inquiry-based science and labs and hands-on things, and the garden gives me that chance. And I feel like they won't take that away from me" (*Article 32, Meredith).

Solve problems together
Haim: Teacher, the seeds might be sleeping! They don't wake up!
Jisub: Maybe, didn't it die by drowning?

TaeJun: Hey, seeds won't come out if it's cold. Maybe, isn't that because of cold weather?
Jisub: Then let's cover the seeds with a blanket!
TaeJun: That's a good idea! But would it be okay to water and cover them? (Students, Article 4)

Ownership of learning
"I think it's good that everyone comes together and shares ideas: children have very different ideas compared to the adults. It gives the children part ownership in what's going on" (Teacher PEO3, Article 31).

Learning work ethics
"We are devoting time to what we really want and we own our own time (…) we celebrate a kind of leisure time which is creative and constructive and is not taken up by consumption" (P8:110, Article 5).

School gardens offer place-based learning opportunities and promote students to discuss the content knowledge they learned and the experiences that actively engaged them (Burt et al., 2018; McMillen et al., 2019). It is an appropriate tool for discovery learning as it makes the students engrossed in their activities. Their curiosity can be a springboard for analytical and innovative participation. The impact on the cognitive domain in this scenario is exhibited by their curiosity and wonder that Cross and Kahn (2018), and Davis and Brann (2017) consider as reconciling curricular linkages and learning opportunities.

Theme 5: Transmissible learning

Schools as educational institutions continuously develop reforms from the numerous salient findings from scientific research. These circumstances suggest that learning should never stop and that it should be shared with others through natural progression, community building, and various development scaffolding (Dunkley, 2016; Eugenio-Gozalbo, Pérez-López, & Tójar-Hurtado, 2020; Fifolt & Morgan, 2019). The transactional nature of garden-based education brought about by the interaction of learners with the community to build knowledge aligns with the constructivism theory (Xie et al, 2018). In this context, students' manifest progression of learning as they share functional knowledge with the family. Similarly, there is evidence of knowledge transfer from the community to the learners or from other stakeholders that characterizes intergenerational learning (Schneller et al., 2015). Engaging students in gardening provides opportunities and a sense of achievement when students share information through different models of learning. Some of the respondents affirmed transmissible learning from the following vignettes:

Intergenerational learning
"I told my parents about the aquaponics system, about how it circles and what's good for the plants and fish. They thought it was a cool idea" (Student, Article 11).

Shared responsibility
"They all take care of each other and remind each other, give each other encouragement … [they show] teamwork, working together, rule-following" (Article 23).

Transformational Education
Moreover, OLGs both embrace living processes and provide ways to engage students with food production, which was considered transformative: "Truly, gardens are a key for educational transformation" (P5:23, Article 5).

There are science lessons wherein students spontaneously or consciously tell others about what they have learned in school. This may be done through formal, non-formal, or informal settings across generations (i.e., children to their parents or older relatives, or to other people groups)in order to gain or share knowledge or skills. This finding is similar to the results of Brion and Cordeiro (2018) who pointed out that there is a transfer of learning when learners are self-motivated and willing to engage in conversation and collaboration.

From the 22 subcategories synthesized from the articles, five themes describing cognitive learning emerged. These themes characterized the different ways that the cognitive dimension of learning can be facilitated through the implementation of garden-based education (Williams, 2018). Integrating such curricular enhancement at the tertiary level particularly in the context of environmental science, in the science education program will be beneficial, as these preservice teachers will become implementers of GBE when they teach (Eugenio-Gozalbo, Aragon, & Ortega-Cubero, 2020). The use of school gardens enables the curriculum to come alive as students see the "real-life" lessons they learn. The GBE can encourage students to engage in experiential learning, discover new things, and develop skills such as responsibility, teamwork, accountability, and environmental stewardship (Burt et al., 2018). The synthesized findings revealed a preponderance of beneficial impacts on the cognitive dimensions of learning using garden-based education. The adoption of instructional gardens has become more popular as a means to address the wellness and hunger issues of the sustainable development goals, and more so, it creates an impact on the learner's cognition of becoming a productive citizen.

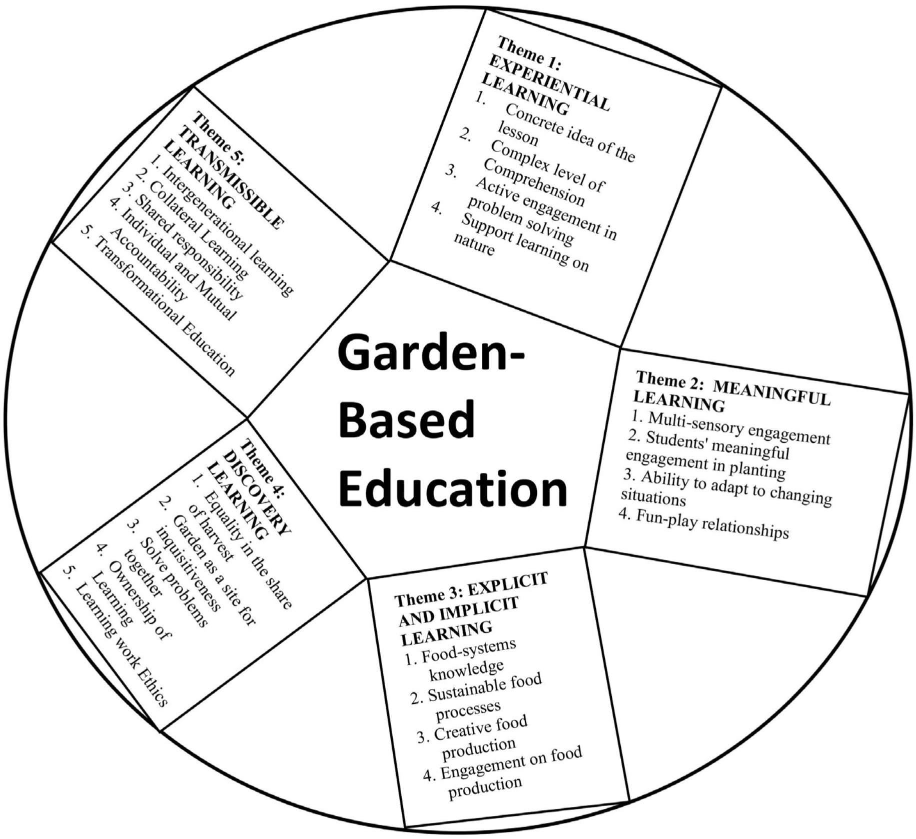

Figure 3. *Thematic map of the impact of garden-based education on cognitive domain of learning*

4.0 Conclusion and Recommendations

This metasynthesis elucidated the different ways that the integration of garden-based education program in the curriculum supported the development of cognitive domain of learning. School administrators and teachers should provide learning opportunities through school garden to support the learner by exposing them to different mechanism and aspects of garden-based instruction not only for enhanced academic outcome but also for other areas of development. In order to maximize the successful and sustainable implementation of GBE in promoting holistic development of learners, this study recommends that the integration have to be mandated in the discipline where the teacher can formally integrate school garden learning in their lesson to bridge the concepts and real-life application. Moreover, in order to achieve a sustainable garden-based learning, integration should be extended up to the higher education courses such as in the environmental science and in the teacher education program. Preservice teachers in general and science teachers in particular are most likely be the one to utilize garden-based learning in the interdisciplinary approach of instruction.

References

Acharya, K. P. (2019). Demystifying science teachers' epistemic belief on chemical concepts: students' engagement in the school garden. *Pedagogical Research, 4*(4). https://doi.org/10.29333/pr/5943

Bailey, D. L., & Falk, J. H. (2016). Personal meaning mapping as a tool to uncover learning from an out-of-doors free-choice learning garden. *Research in Outdoor Education, 14*, 64-85. https://digitalcommons.cortland.edu/cgi/viewcontent.cgi?article=1037&context=reseoutded

Beasley, K., Lee-Hammond, L., & Hesterman, S. (2021). A framework for supporting the development of botanical literacies in early childhood education. *International Journal of Early Childhood, 53,* 119-137. https://doi.org/10.1007/s13158-021-00291-x

Burt, K. G., Luesse, H. B., Rakoff, J., Ventura, A., & Burgermaster, M. (2018). School gardens in the United States: Current barriers to integration and sustainability. *American Journal of Public Health, 108*(11), 1543-1549. https://doi.org/10.2105/AJPH.2018.304674

Braun, V., & Clarke V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology, 3*(2), 77-101. http://dx.doi.org/10.1191/1478088706qp063oa

Brion, C., & Cordeiro, P. A. (2018). Learning transfer: The missing link to learning among school leaders in Burkina Faso and Ghana. *Frontiers in Education, 2*(69), 1-12. https://doi.org/10.3389/feduc.2017.00069

Carlsson, L., Williams, P. L., Hayes-Conroy, J. S., Lordly, D., & Callaghan, E. (2016). School gardens: Cultivating food security in Nova Scotia public schools? *Canadian Journal of Dietetic Practice and Research: A Publication of Dietitians of Canada = Revue Canadienne De La Pratique Et De La Recherche En Dietetique: Une Publication Des Dietetistes Du Canada, 77*(3), 119-124. https://doi.org/10.3148/cjdpr-2015-051

Chrastina, J. (2018, July 17). *Meta-Synthesis of qualitative studies: Background, methodology, and applications* [Conference session]. NORDSCI International Conference Proceedings: Education and Language Edition, Helsinki, Finland. https://files.eric.ed.gov/fulltext/ED603189.pdf

Cheang, C. C., So, W.-M. W., Zhan, Y., & Tsoi, K. H. (2017). Education for sustainability using a campus eco-garden as a learning environment. *International Journal of Sustainability in Higher Education, 18*(2), 242–262. https://doi.org/10.1108/IJSHE-10-2015-0174

Christodoulou, A., & Korfiatis, K. (2018). Children's interest in school garden projects, environmental motivation and intention to act: A case study from a primary school of Cyprus. *Applied Environmental Education & Communication,* 1–11. https://doi.org/10.1080/1533015X.2017.1419104

Cohen, L., Marion, L., & Morrison, K. (2011). *Research methods in education* (7th ed.). Routledge.

Contreras, R. (2011). Examining the context in qualitative analysis: The role of the co-occurrence tool in ATLAS.ti. *Atlas.ti Newsletter*, 5-6. http://downloads.atlasti.com/library/contreras_nl201108.pdf

Cramer, S. E., Ball, A. L., & Hendrickson, M. K. (2019). "Our school system is trying to be agrarian": Educating for reskilling and food system transformation in the rural school garden. *Agriculture and Human Values, 36*, 507–519. https://doi.org/10.1007/s10460-019-09942-1

Cross, S. M., & Kahn, S. (2018). Science in the garden: A qualitative analysis of school-based agricultural educators' strategies. *Journal of Agricultural Education, 59*(4), 88-104. https://doi.org/10.5032/jae.2018.04088

Davis, K. L., & Brann, L. S. (2017). Examining the benefits and barriers of instructional gardening programs to increase fruit and vegetable intake among preschool-age children. *Journal of Environmental and Public Health, 2017*, 1-7. https://doi.org/10.1155/2017/2506864

Dickey, K. J., Boren Alpizar, A. E., Irlbeck, E., & Burris, S., (2020). One seed at a time: Prosocial youth development in an urban agriculture program. *Journal of Agricultural Education, 61*(1), 110-127. https://doi.org/10.5032/jae.2020.01110

Dunkley, R. A. (2016). Learning at eco-attractions: Exploring the bifurcation of nature and culture through experiential environmental education. *The Journal of Environmental Education, 47*(3), 213–221. https://doi.org/10.1080/00958964.2016.1164113

Ertmer, P. A., & Newby, T. J. (2013). Behaviorism, cognitivism, constructivism: Comparing critical features from an instructional design perspective. *Performance Improvement Quarterly, 26*(2), 43-71. https://doi.org/10.1002/piq.21143

Eugenio-Gozalbo, M., Aragon, L., & Ortega-Cubero, I. (2020). Gardens as science learning contexts across educational stages: Learning assessment based on students' graphic representations. *Frontiers in Psychology, 11*. https://doi.org/10.3389/fpsyg.2020.02226

Eugenio-Gozalbo, M., Pérez-López, R., & Tójar-Hurtado, J.-C. (2020). Identifying key issues for university practitioners of garden-based learning in Spain. *Journal of Environmental Education, 51(*3), 246–255. https://doi.org/10.1080/00958964.2019.1687407

Fifolt, M., & Morgan, A. F. (2019). Engaging K-8 students through inquiry-based learning and school farms. *Journal of Education for Students Placed at Risk (JESPAR), 24*(1), 92–108. https://doi.org/10.1080/10824669.2018.1545583

Friese, S. (2015). ATLAS.ti 7: User guide and reference. In *ATLAS.ti 7 user manual.* ATLAS.ti Scientific Software Development. http://

downloads.atlasti.com/docs/manual/atlasti_v7_manual_en.pdf

Greer, A. E., Rainville, K., Knausenberger, A., & Sandolo, C. (2019). Opportunities for school garden-based health education in a lower-income, diverse, urban school district. *American Journal of Health Education, 50*(4), 257–266. https://doi.org/10.1080/19325037.2019.1616010

Jones, M., Weitkamp, E., Kimberlee, R., Salmon, D., & Orme, J. (2012). Realizing a holistic approach to food through school gardens and growing activities. *Children, Youth, and Environments, 22*(1), 75–98. https://doi.org/10.7721/chilyoutenvi.22.1.0075

Jorgenson, S. (2013). The Logic of School Gardens: A Phenomenological Study of Teacher Rationales. *Australian Journal of Environmental Education, 29*(2), 121–135. https://doi.org/10.1017/aee.2014.1

Kangas, M., Vesterinen, O., Lipponen, L., Kopisto, K., Salo, L., & Krokfors, L. (2014). Students' agency in an out-of-classroom setting: Acting accountably in a gardening project. *Learning, Culture and Social Interaction, 3*(1), 34–42. https://doi.org/10.1016/j.lcsi.2013.12.001

Kim, K. J., Jung, E., Han, M.-K., & Sohn, J.-H. (2020). The power of garden-based curriculum to promote scientific and nature-friendly attitudes in children through a cotton project. *Journal of Research in Childhood Education, 34*(4), 538–550. https://doi.org/10.1080/02568543.2020.1718251

Laaksoharju, T., Rappe, E., & Kaivola, T. (2012). Garden affordances for social learning, play, and building nature–child relationship. *Urban Forestry & Urban Greening, 11*(2), 195-203. https://doi.org/10.1016/j.ufug.2012.01.003

Lachal, J., Revah-Levy, A., Orri, M., & Moro, M. R. (2017). Meta-synthesis: an original method to synthesize qualitative literature in psychiatry. *Frontiers in Psychiatry, 8,* 269. https://doi.org/10.3389/fpsyt.2017.00269

Lehnerd, M. E., Goldberg, J. P., Folta, S. C., Cash, S. B., Griffin, T. S., Lucas, R., & Sacheck, J. M. (2019). Qualitative exploration of farm to school program adoption and expansion in Massachusetts schools. *Journal of Hunger & Environmental Nutrition, 15*(2), 230–250. https://doi.org/10.1080/19320248.2019.1610539

McMillen, J. D., Swick, S. D., Frazier, L. M., Bishop, M., & Goodell, L. S. (2019). Teachers' perceptions of sustainable integration of garden education into head start classrooms: A grounded theory approach. *Journal of Early Childhood Research, 17*(4), 392–407. https://doi.org/10.1177/1476718X19856378

Miles, M. B., Huberman, A. M., & Saldaña, J. (2014). Qualitative data analysis: A methods sourcebook (3rd ed.). Sage. https://kupdf.net/download/qualitative-data-analysis-a-methods-sourcebook-third-edition_5910b0f8dc0d60e62e959e9a_pdf#

Mohamed, N., & Othman, N. (2018). Experiential learning: Botanical garden as a place for learning plant science. *Asian Journal of Quality of Life, 3*(12), 61-68. https://doi.org/10.21834/ajqol.v3i12.142

Murakami, C. D., Su-Russell, C., & Manfra, L. (2017). Analyzing teacher narratives in early childhood garden-based education. *Journal of Environmental Education, 49*(1), 18–29. https://doi.org/10.1080/00958964.2017.1357523

Rich, H., & Ardoin, N. M. (2014). Teacher and administrator perceptions of school gardens in Cape Town, South Africa. *Children, Youth, and Environments, 24*(3), 58–79. https://doi.org/10.7721/chilyoutenvi.24.3.0058

Ruiz-Gallardo, J. R., Verde, A., & Valdés, A. (2013). Garden-based learning: An experience with "at risk" secondary education students. *The Journal of Environmental Education, 44*(4), 252-270. https://doi.org/10.1080/00958964.2013.786669

Schneller, A., Schofield, C. A., Frank, J., Hollister, E., & Mamuszka, L. (2015). A case study of indoor garden-based learning with hydroponics and aquaponics: Evaluating pro-environmental knowledge, perception, and behavior change. *Applied Environmental Education and Communication, 14*(4), 256–265. https://doi.org/10.1080/1533015X.2015.1109487

Williams, D. R. (2018). Garden-based education. In *Oxford Research Encyclopedia of Education.* Oxford University Press. https://doi.org/10.1093/acrefore/9780190264093.013.188

Acknowledgment

The authors wished to extend their gratitude to the Cebu Normal University, especially to the Research Institute for Tropical Biology and Pharmacological Biotechnology (RITBPB), for the financial grant provided for this study.