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Implementation of environmental care character for elementary school students through verticultural culture techniques

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ABSTRACT

The limited area of planting land requires the agricultural system to increasingly utilize a minimalist space in order to produce products that the community wants. This can be done with vertical farming cultivation techniques. This system is suitable to be applied in limited land or in densely populated settlements. One of them is in SD Muhammadiyah Wirobrajan 3 which has limited land. The target of this community service program is 4th grade students of SD Muhammadiyah Wirobrajan 3, Yogyakarta. The implementation activities of this service can be divided into three stages, namely the counseling stage on the introduction of verticulture cultivation techniques to participants, the demonstration stage in the form of vegetable crop cultivation training, and the monitoring stage which is carried out two weeks after the implementation of the service. The vertical rack used is in the form of a vertical paralon pipe rack. Vegetable seeds planted are chicory seeds, spinach, caisim and lettuce. While the planting media used is a mixture of garden soil, compost, husk charcoal, dolomite and NPK fertilizer which is mixed homogeneously so that it is ready for use. At the age of two weeks after planting, the seeds planted on the vertical paralon have begun to appear, indicating plant growth. The introduction of a vertical farming system to students in addition to having a direct impact on the greening of the school environment can also be a form of learning facilities in schools to love the environment more.

KEYWORDS
Vertical;
Environmental education;
Student character enhancement;
Care for the environment

1. Introduction

Currently, a large area of agricultural land has begun to be converted into non-agricultural land. Based on the 2013 agricultural census in Yogyakarta, the average area of agricultural land has decreased compared to the agricultural census in 2003 from BPS DIY in 2015. Land use competition occurs in developing areas where the availability of agricultural land is increasingly limited. Most of the land ownership is dominated by corporates and capital owners [1]. This indicates that the potential for the use of rice fields is decreasing which is being converted into non-agricultural land, such as industrial and household land.

The problem of land conversion is getting bigger because the policy makers are not responding to the issue. Policy makers can help strengthen land-owning farmers in terms of financial policies and facilitate collaboration with industry [2]. Land conversion is closely related to financial problems, where farmers are in a weak position. Farmers can be strengthened by facilitating collaboration with industry. Other policies that can facilitate farmers are land irrigation systems, organic farming support and labor wages [3]–[5].

Contract farming policies have been implemented to improve the bargaining position of farmers. Contract farming involves industry to support farmers by providing increased access to quality inputs, technical support to market outputs [6]. For example, contract farming between supermarkets and farmers to supply their vegetable needs [7]. This system is gaining popularity in many developing countries, although it is considered less significant when applied in rural areas [8]. This contract farming application has been proven to increase the profits of farmers who have small or limited land, supported by the use of

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high quality seeds [9]. Farmers who apply contract farming are able to demonstrate adaptive capabilities and are relatively little affected by the Covid-19 pandemic [10].

The limited area of planting land requires the agricultural system to increasingly utilize the limited space in order to produce the products that the community wants. This production is related to the fulfillment of food needs, the comfort of living in the midst of population density and presenting an aesthetic nuance. This can be done with vertical farming cultivation techniques. This system is suitable to be applied in limited land or in densely populated settlements. This system can be a solution for agricultural land that has been converted into industrial and residential land as an effort to support food sufficiency, security and independence [11]. Vertical cultivation can coexist with buildings because it can add to the aesthetic value of buildings, and can be placed indoors or outdoors without disturbing the functions of other buildings [12], [13].

Verticulture is a farming technique using vertical planting containers to overcome land limitations [14]. Cultivation of plants using this technique can be arranged into several levels so as to be able to make efficient use of land [15]. The planting system uses various materials that are around, such as wood, bamboo, paralon pipes, pots, plastic bags, earthenware as well as plastic and glass bottles. The types of plants that can be grown vertically vary, for example seasonal fruit and vegetable crops (mustard, lettuce, cabbage, carrots, tomatoes, eggplants, chilies and others), as well as flower and ornamental plants such as orchids, bougenville, roses, jasmine, azeleas. and hibiscus) [16]. Pots where planting containers can be installed on the wall vertically using additional iron construction as in some hotels in the Sleman Region, Yogyakarta. In fact, verticulture techniques can be modified with aquaponics techniques to cultivate plants as well as fish to fulfill family food security [17]. In addition to providing aesthetic value, vertical cultivation techniques also increase community participation for sustainable agriculture on limited land [18].

Environmental education in supporting agricultural sustainability needs to be given to all levels of society including students in schools. One of them is to introduce the recycling culture of surrounding waste to students as a planting container. Food packaging waste that is commonly found in the school environment can be recycled into goods that have use value. Especially waste made from plastic which is difficult to decompose and can cause soil and water pollution [19]. With vertical cultivation involving students in schools, besides having a direct impact on reforestation in schools, this activity can also be used as a means of student learning. Environmental education related to vertical cultivation in this service activity was carried out at SD Muhammadiyah Wirobrajan 3, Yogyakarta City.

SD Muhammadiyah Wirobrajan 3 is located in the middle of a densely populated area and has a narrow area of land. The majority of students also live in densely populated settlements. Limited land resulted in the growth and development of children who were confined in the middle of the walls of the house that were close together and far from plants and animals. Whereas biological resources in the surrounding natural environment have great potential as a natural laboratory for learning. On the page, children can learn by using real objects. The contribution of this activity is expected for students to know and be able to apply vertical culture techniques, both at school and at home, as one of the application values of students' environmental care character. This is expected to have an impact on increasing family food security, as well as utilizing limited land and increasing the aesthetic value of the surrounding environment.

2. Implementation Method

The method used in this community service activity begins with the Participatory Rural Appraisal (PRA) approach, then continues with counseling, training and mentoring activities. The choice of using the PRA method is based on the active involvement of students (as subjects), while universities only act as facilitators. The training provided in this activity is in a participatory form, which focuses on the

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participation of students. Comparison of the implementation is 30% for educational theory and 70% for verticulture manufacturing and maintenance practices.

This service activity is divided into three stages, including: program consolidation, demonstration activities, and monitoring.

2.1. Program consolidation

At this stage the community service team introduces the service plan for the Principal and teachers at SD Muhammadiyah Wirobrajan 3, and explains the details of the activities that will be carried out based on mutual agreement. At this stage, an agreement was made on the timing and schedule of demonstration activities which included counseling and training on vertical cultivation. This is done so that all students and teachers can participate in demonstration activities that will be carried out and know the duties of each party during the implementation of the activity.

2.2. Demonstration activities

This activity is the core of the community service carried out by the team because in this activity the residents of SD Muhammadiyah Wirobrajan 3 will see firsthand and practice verticulture techniques. Thus, 4RF students have knowledge and insight about the cultivation technique. The demonstration activity is divided into two stages:

2.2.1. Conducting education or counseling in the form of lectures

This counseling introduces the meaning of verticulture, the benefits obtained by planting verticulture, containers that can be used and the types of plants that can be grown with verticulture cultivation.

2.2.2. Hands-on practice of making vertical culture techniques

It is intended that students not only gain knowledge, but also skills in vertical engineering applications. The stages carried out in the application of vertical cultivation techniques are:

- Preparation of planting media for verticulture. The mixture of planting media used for training is a mixture of garden soil with compost and husk charcoal. In addition, there is the addition of dolomite and NPK fertilizer. The various ingredients are mixed until homogeneous using a soil hoe or shovel.
- Vertical rack. For this service, the rack model/design used for verticulture is a paralon pipe which is designed in such a way as a place for media and plant growth.
- Planting. After the vertical paralon is filled with media, the soil mixture in the vertical pipe is sprayed with water so that the planting media is moist. The seeds used are chicory seeds, spinach, caisim and lettuce.
- Fertilization. If the planting has been completed, the plant media is sprayed with organic fertilizer according to the dosage stated on the package. Fertilization is done regularly every 7 days.

2.3. Monitoring

At this stage, the community service team monitors the growth of vertical plants. This is also done to provide consulting services to students and school residents regarding problems that arise during the maintenance of plant cultivation using the vertical system. Harvesting is done about 30-75 days after planting vegetable seeds, depending on the type of vegetable seeds planted.

3. Results and Discussion

Participants in the implementation of this activity amounted to 20 people, including representatives of fourth grade students and representatives from the teacher. The implementation activities of this service can be divided into 3 stages, namely the counseling stage on the introduction of verticulture cultivation

techniques to participants, the demonstration stage in the form of vegetable crop cultivation training, and the monitoring stage which is carried out 2 weeks after the implementation of the service.

3.1. Counseling stage

At this stage, counseling is held to students regarding the introduction of verticulture cultivation techniques as shown in Fig. 1. The figure shows that this activity is very useful so that students understand about verticulture cultivation. Students are able to identify the differences between vertical farming techniques and other crop cultivation techniques. The introduction of various planting media containers including used materials for verticulture techniques as well as providing education to students about recycling, as an effort to save the environment. The students were very enthusiastic about participating in the counseling activities. Some students have actually seen the vertical application in the surrounding environment, it's just that they don't know the mention of the term. The vertical system is often found by students in several city parks.

Fig. 1. Extension of vertical techniques to students

Students' knowledge about verticulture, before and after counseling is shown in Table 1. The table shows that students are able to identify the differences between verticulture techniques and other crop cultivation techniques. The introduction of various planting media containers including used materials for verticulture techniques as well as providing education to students about recycling, as an effort to save the environment. The students were very enthusiastic about participating in the counseling activities. Some students have encountered verticulture in the surrounding environment and city parks. However, as many as 67% of students have never known and encountered verticulture in some city parks.

Table 1. Students's knowledge about verticulture, before and after counseling

No	Information	Percentage
	Before counseling	
1	Students who are familiar with verticulture	33%
2	Students are not familiar with verticulture	67%
	After counseling	
1	Students who are familiar with verticulture	0%
2	Students are not familiar with verticulture	21%
	A total of 21 students	

3. Training stage

After the counseling, the next stage was demonstration activities in the form of vegetable crop cultivation training for students. It is intended that the extension students not only gain knowledge, but also skills about vegetable crop cultivation using verticulture techniques. Furthermore, students are

expected to be able to practice these agricultural techniques at school and at home independently to take advantage of the limited land. The steps taken are:

3.2.1 Preparation of planting media for verticulture

The mixture of planting media used for training is a mixture of garden soil with compost and husk charcoal. The ratio used is 3:3:1 (3 sacks of garden soil, 3 sacks of compost and 1 sack of charcoal husk) for all the materials used. In addition, the addition of dolomite (1 bag) was carried out to neutralize soil pH and provide suitable conditions for soil microorganism activity. Dolomite contains components of lime (Ca) and magnesium (Mg). 2 kg of NPK fertilizer was also added to provide the nutrients needed by plants, in the form of nitrogen, phosphorus and potassium. The various materials are mixed until homogeneous using a hoe or soil shovel as shown in Fig. 2. The picture shows that children are very happy to know vertical plants.

3.2.2. Vertical shelf

For this service the model/design of the rack used for verticulture is a paralon pipe which is designed in such a way as a medium for plant growth and is shown in Fig. 3. The image shows that the vertical paralon is positioned in a standing (vertical) in the pot, and the outside of the paralon filled with a mixture of gravel to hold the paralon pipe in place. While the inside of the paralon is filled with a mixture of planting media that has been made previously.

3.2.3. Planting

After the vertical paralon is filled with planting media, the soil mixture in the vertical pipe is sprayed with water so that the planting media is moist. Furthermore, for planting vegetable seeds, the planting medium is perforated with wood or index finger and filled with 2-3 vegetable seeds for each hole. The hole made does not need to be too deep, only about 2 cm deep. Then the planting hole is closed again with planting media, as shown in Fig. 4. The seeds used in this service are chicory seeds, caisim, lettuce and spinach.

Fig. 2. Mixing materials for vertical cultivation media

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Fig. 3. Vertical rack used in service activities

3.2.4. Fertilization

When planting has been completed, the plant media is sprayed with organic fertilizer according to the dosage stated on the package, which is 3-4 ml of biological fertilizer/liter of water (or with a half-cap of a bottle of fertilizer for 1 liter of water). Fertilization is done regularly every 7 days. If during planting there are pests that attack, biopesticides can be applied to vegetable crops. The dose used is 5 ml of biopesticide for 1 liter of water, and it is sprayed on vegetable plants affected by pests and diseases. Spraying of biopesticides can be done 2-3 times during the planting period.

3.3. Monitoring

This monitoring was carried out two weeks after the implementation of the counseling and training. The goal is to monitor the development of plants that are planted with verticulture techniques. Two weeks after planting, the vegetable seeds that have been planted on the vertical rack have started to grow as shown in Fig. 4. The figure shows that harvesting is carried out about 30-75 days after planting the vegetable seeds, depending on the type of vegetable seeds planted.

Fig. 4. Seed growth of vegetable crops two weeks after planting

In this service, partners play an active role in the implementation of activities. Partners have provided a location for the implementation, in addition to coordinating the training participants. In addition, the need for water during training and maintenance of vertical crops is also the responsibility of the partners. Sustainability of this activity carried out by fourth grade students accompanied by their homeroom teacher includes watering plants, maintaining and monitoring plant growth by implementing a student picket system.

In addition to introducing and practicing plant cultivation techniques vertically, verticulture education is also one of the media for student learning related to strengthening and strengthening children's character

values to care more about the environment. Students have the awareness to be more concerned with plant life because they directly water the plants and monitor their growth from sprouts to large plants.

Vertical technique is very possible in the future to be developed in various school environments to support learning. Students can observe the phases of plant growth and are given responsibility for maintenance. This has a role to foster love and care for plants and the environment. Students are more interested in participating in learning through practice and observing plants directly. Several studies have confirmed that the general public are very interested in and accept this verticulture technique for cultivating fruit and vegetables at home and in their environment, although basic knowledge related to verticulture must be mastered so that the yield of cultivated plants can grow optimally [13], [20].

The large community acceptance of vertical cultivation allows it to be applied in various locations. The vertical cultivation system is one of the urban farming strategies that is able to produce various vegetable stocks in the urban environment [21]. Vegetables can be produced continuously throughout the year in a controlled environment compared to cultivating in large fields, under various biotic and abiotic stresses [22]. In fact, the development of vertical cultivation has increasingly encouraged various industries to conduct research on agriculture in a controlled environment [23]. Given the various lucrative advantages of the vertical cultivation system.

Agricultural production using verticulture is no less far from conventional agriculture, in open and wide land. Vertical cultivation of plants is still able to maintain the production and content of nutritious secondary metabolites possessed by plants, with limited and controlled environmental variables [24], [25]. Increased public awareness of health and chemical content has further increased the potential of vertical cultivation systems, especially in urban areas [26].

The application of automated data-based agricultural systems through the Internet of Things, artificial intelligence and robotics has begun to shift the development of vertical systems [27], [28]. The current vertical cultivation system is starting to be modified with the application of technology and digitization. For example, the application of digital twin systems or the like based on IoT that is able to control and control the environment [29], [30]. This kind of technology is also possible in the management of pests and diseases [31]. This makes it very easy and increasingly supports the community to manage their vertical cultivation, both indoors and in greenhouses [32]. Setting the light intensity using LED (light-emitting diode) is able to provide an indoor vertical solution [33]. Although this is still being debated because the use of additional energy is considered not environmentally friendly [34]. The existence of indoor verticulture plants is also considered as natural ventilation because it can provide oxygen intake in the room [35].

4. Conclusion

The conclusions of the service activities carried out at SD Muhammadiyah Wirobrajan 3 include this community service activity can be divided into three stages, namely the stage of counseling on verticulture cultivation techniques, the training stage for vegetable crop cultivation, and the monitoring stage which is carried out two weeks after implementation. Partners, especially students of SD Muhammadiyah Wirobrajan 3, gain knowledge and skills in making verticulture and their benefits.

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Author contribution

The method used in this community service activity begins with the Participatory Rural Appraisal (PRA) approach, then continues with counseling, training and mentoring activities.

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Conflict of interest

The authors declare no conflict of interest.

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