

The Improvement of Prospective Teachers' Habits of Mind during the 5E+e Inquiry Learning Program in Horticulture Course

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ABSTRACT

Habits of mind are important things to be equipped to prospective teachers. In order to be able to solve every problem they face, prospective teachers should be used to have self-regulation, critical thinking, and creative thinking. Therefore, to achieve these objectives, appropriate learning experience and strategies are needed. In this article, an entrepreneurship-oriented 5E (Engagement, Explain, Exploration, Elaboration, and Evaluation) inquiry learning program is developed, it is also called 5E+e. The focus of this article is to investigate the improvement of prospective teachers' Habits of Mind during horticulture course through the 5E+e inquiry learning program. The quasy experiment method was used in this study with one group pretest-posttest design with the involvement of 31 Biology Education students in one teachers Institution in Central Java on their sixth semester who took the horticulture course. Data were collected using questionnaires and observation sheets in the form of a Habits of Mind rubric adapted from the Marzano's framework. Data were then analyzed in quantitative and in qualitative descriptive manner from various sources, so as to obtain comprehensive conclusions. Research results show an improvement on the average Habits of Mind score of prospective teachers, where the average score collected before the program was given was at 2.68; and the average score after being given the program was at 3.34 of 4.00 scale. The calculated N-gain is 0.31; which is in the moderate category. The data were supported by the results of observations during the learning process which at each stage shows progress, i.e. stage I (3.11), stage II (3.08), stage III (3.39), and stage IV (3.59). Based on the findings, students can cultivate horticultural crops creatively with a variety of planting techniques, critical when observing plant growth and development, and diligent in maintaining a successful crop cultivation project. Thus, it can be concluded that 5E+e inquiry learning program implemented in horticultural course can greatly improve the Habits of Mind of prospective teachers.

Keywords: habits of mind, prospective teacher, 5E+e inquiry, horticulture

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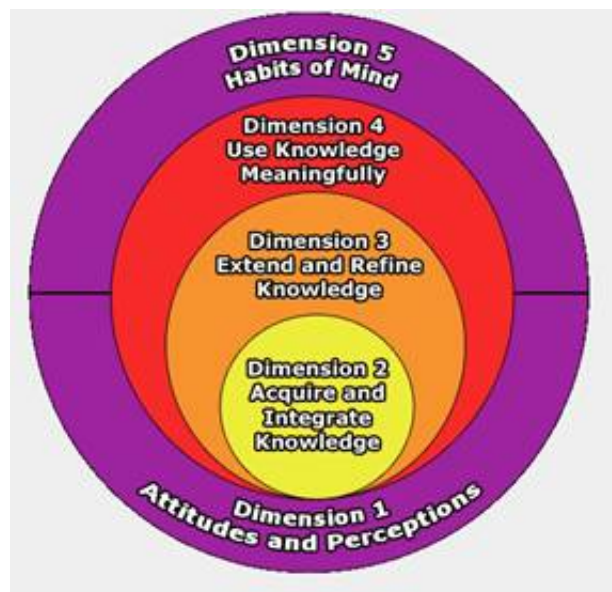


Figure 1. Dimensions of learning (Marzano, 1992)

INTRODUCTION

Biology objects have great potential to support the needs of human life. The field of plant studies, such as horticulture is one of the life sciences groups that is rich in natural potency, each species of plant even has value to be developed in the concept of entrepreneurship. However, if not managed properly the potential of these plant species will be misused, causing an imbalance to the environment. Therefore, education should be focused in anticipating these problems by offering future-oriented learning concepts (life-long learning). Learning that is able to optimize the potential of biology objects without aiming to exploit, but visioning to conserve, preserve and prepare life for future generations.

To achieve these objectives, good young generation need to be prepared, and so the habits of mind of prospective biology teachers must be equipped. They should be accustomed to thinking critically when obtaining information, thinking creatively in solving problems and being able to control themselves in any situation. Therefore, learning should be built with fun and meaningful. There are five dimensions of learning that must be done to fit these objectives (Marzano, 1992): attitudes and perceptions, acquiring and integrating knowledge, extending and refining knowledge, using meaningful knowledge, habits of mind (see **Figure 1**). In a different book, it was stated that the five dimensions of learning are interrelated and cannot be used separately, and habits of mind are one dimension of long-term learning (Marzano, 1994). Habits of mind is used as a response to questions and answers to problems that are not immediately known (Nuraeni, 2016), even it is said that someone who has good habits of mind will have good quantitative literacy as well (Grawe, 2011; Steen, 2001). Someone who has good habits of mind, then she will have good high level thinking skills and smart thinking (Gloria et al., 2017). Habits of mind as intelligent behavior can be trained and measured, all this is possible if science education emphasizes inquiry-based learning and is supported by the application of authentic and formative assessments (Rustaman, 2011).

In order for students' habits of mind to be properly maintained, learning must be designed according to the appropriate learning dimensions. Inquiry is a strategy that is representative for biology learning, because in the learning process it involves activities that are in accordance with biological concepts, such as: observation, asking questions, investigating, review of experimental evidence, data collection and interpretation, propose answers, give explanations, predict, and communicate results (NRC, 1996). Even in science, especially biology, inquiry is not a foreign term, because the essence of science is inquiry itself (Rustaman, 2005). That is, the nature of science is the inquiry itself. The nature of science is the process, product and value/ attitude (Toharudin et al., 2011). However, inquiry alone is not enough to overcome the above problems, inquiry must be directed towards real-world applications (Hayat & Rustaman, 2017). Therefore, in this study inquiry is integrated with entrepreneurial values. It is intended that students in learning biology are not only involved in scientific activities, but also direct biological concepts (such as horticulture) on their use for everyday life.

Even more, students have awareness to conserve and preserve biology natural resources oriented to sustainable development.

The need for sustainable skills development will continue to be felt by everyone at all ages as there are many jobs in the future that do not exist today (Cummins & Kunkel, 2015). Some science experts argue that science learning, especially biology which emphasizes concept mastery without the provision of life-long learning, worse an already unpromising conditions despite having a diploma at various levels of education, thus challenging educators of pre-service teachers and educational practitioners to find solutions (Rustaman, 2016). Life-long learning has become a key word in almost all countries because of its increasing influence on education policy in the global world (Regmi, 2015), even nowadays life-long learning has become an international development agenda (Preece, 2013). For example, in Singapore life-long learning is a big topic in the discourse of human resources, employment, entrepreneurship, and national education. In fact, the government has implemented life-long learning in education as a strategy to be survive in the country (Ng, 2013). In other countries such as PRC (People's Republic of China), and European countries, life-long learning has become a global phenomenon that significantly changes the basic form of a conventional national education system. Life-long learning in China has the potential to offer real changes to social goals that are maintained to a certain extent (Wang et al., 2017). While in Europe, life-long learning is an EU priority that has been going on for a long time, with an emphasis on the main needs pursued by everyone (Ingham et al., 2016).

Life-long learning should have meaningful and enjoyable learning goals. Therefore, in a study it is said that learning is a transformation of happiness, joy, success, and lifelong learning disposition for students as well as various challenges, sufferings and difficulties (Li, 2016). Other research suggests that lifelong learning has been pragmatically positioned to support China's modernist development project, culminating in a proclamation to move from "made in China," which is a manufacturing-based economy, to "created in China", namely a knowledge-based economy (Shan, 2017).

Habits of mind is one of the five standards of Marzano's framework life-long learning (Marzano et al., 1994). This standard has three aspects, i.e. self-regulation, critical thinking, and creative thinking. In its implementation, the three aspects are measured based on the program developed, namely entrepreneurship-oriented inquiry learning that is applied to horticultural course. This learning program is an integration of the 5E inquiry model (Engagement, Exploration, Elaboration, and Evaluation) adapted from Bybee (2009) and the principles of entrepreneurship (CEE, 2004), so it is called 5E+e inquiry. Based on these problems, the discussion focused on how to improve the habits of mind of prospective biology teachers while attending the 5e+e inquiry learning program in horticultural course.

METHODOLOGY

Design

This paper is part of the developmental research on entrepreneurship-oriented inquiry learning program in plant studies to provide students' life-long learning. The data presented in this article is the data of the implementation of phase I which focused on the development of students' Habits of Mind after taking part in Horticulture course. Habits of Mind is one of the standards in the Marzano's framework life-long learning (Marzano *et al.*, 1994) measured in this study. The program developed is organized into four learning stages, namely: basic, development, advance, and professional. At each stage of learning it was designed with 5E inquiry syntax (engagement, exploration, explain, elaboration, and evaluation) that is integrated with the values of entrepreneurship. The values of entrepreneurship are applied in each stage, i.e. basic in stage I, the values of entrepreneurship instilled are the nature / behavior of the entrepreneur and the discovery of the concept of entrepreneurship; development in stage II, integrated entrepreneurship values are the development of the concept of entrepreneurship and preparation of resources; advance in stage III, the values of entrepreneurship applied are economic & financial literacy, and business management; and proficiency in stage IV, the skills of entrepreneurship that are provided are marketing management and digital skills. The four stages of learning are integrated with entrepreneurship values adapted from CEE (2004).

To test the effectiveness of this program a quasy experimental research method was used with one group pretest-posttest design (Gall *et al.*, 2003). This method is done by comparing the results of pretest and posttest in the group tested. This design is seen as suitable for testing the effectiveness and feasibility of learning programs.

Sample

The research subjects were sixth semester students Biology Education Department in one teachers institution in Central Java. The number of participants involved in this study were 31 students who took Horticulture course.

Instrument

The instruments used in this study in data collection were questionnaires and observation sheets which were arranged in the form of the Habits of Mind rubric, which was developed based on Marzano's framework life-long learning with three aspects, that is: self-regulation, critical thinking, and creative thinking. These three aspects data will be measured for each development as long as students take part in Horticulture course. Rubrics on the questionnaire and observation sheet are arranged in the form of rating scales (4, 3, 2, 1) with descriptions according to the content of each items in the respective rubric.

Data Collection and Analysis

The data collection technique in the questionnaire was carried out with two measurements, that is the initial measurement (pre) taken before the program implementation and the final measurement (post) was taken after the implementation of the program self-assessment. Each student was asked to choose one of four statements that represent his condition for each item on the given Habits of Mind rubric. The observation sheet was used as an instrument to observe the development of the student's Habits of Mind at each meeting in Horticulture course during data collection. The data screening technique was carried out by one observer who observed the performance of students in each group, and the research subjects were divided into six groups.

Data collected from the next questionnaire were analyzed quantitatively by calculating the total mean and average of each aspect of the Habits of Mind. Then the results were interpreted in the form of a comparison diagram between the initial conditions and the final conditions. In addition, the value of N-gain Habits of Mind is also calculated before and after treatment. The data collected through the observation sheet were analyzed by looking at the development of Habits of Mind at each stage of learning, both total development and development in every aspect of Habits of Mind (self-regulation, critical thinking, and creative thinking). Then triangulation of all sources of data that has been collected was analysed to obtain a comprehensive interpretation of the data.

RESULTS AND DISCUSSION

Data collected from the research results were then described and interpreted into two parts, that is: 1) the condition of students' Habits of Mind before and after being given a program (which was collected using a questionnaire); and 2) the development of student Habits of Mind at each stage of learning (which was obtained through observation).

The Initial and Final Conditions of The Student Habits of Mind

The following are data about the condition of the Habits of Mind of students before and after being given the learning program developed. First illustrated the overall condition of the Habits of Mind, as shown in **Figure 2**.

In **Figure 2**, it is shown that students Habits of Mind increases from the state before (2.70) and after having been given the program (3.32) from a maximum score of 4.00. **Figure 2** also explains in more detail that all aspects of the Habits of Mind have increased. However, from the three aspects that show the highest increase is aspects of self-regulation, that is with the final score of 3.42, while the critical thinking aspect is 3.23, and the creative thinking aspect was 3.31 from a total score of 4.00. Actually the scores from the three aspects do not differ significantly, but it can be interpreted that during the learning process students become more aware of their learning needs, such as: preparing careful planning, being aware of the resources needed, and becoming more sensitive to feedback.

Total mean of student's habits of mind

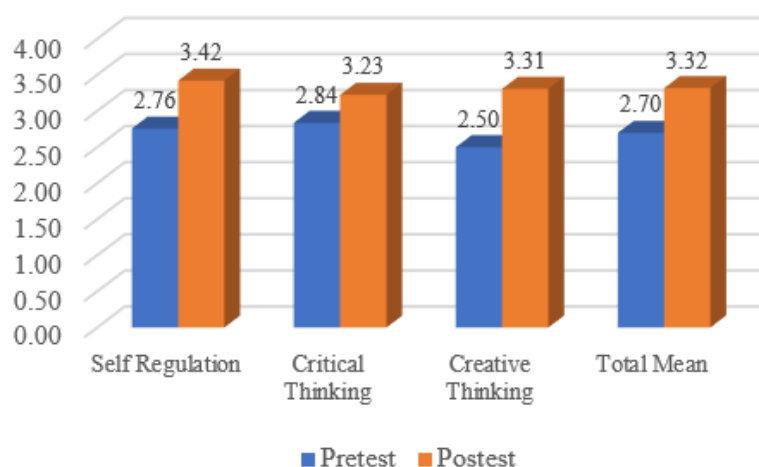


Figure 2. Mean score of overall student habits of mind

Mean score of self-regulation

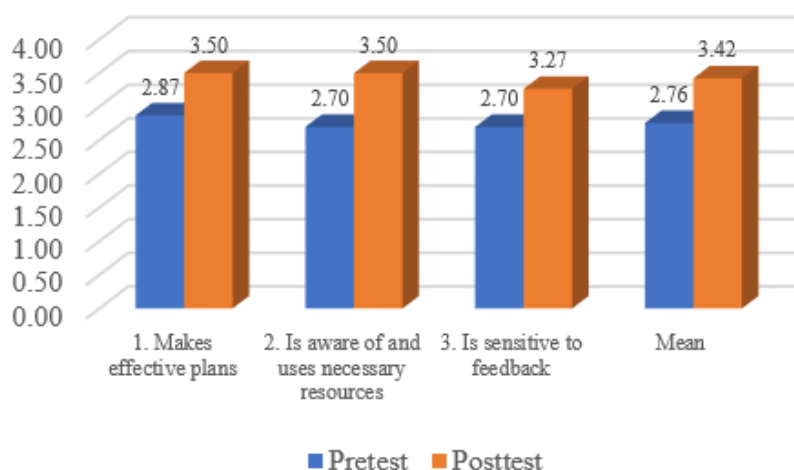


Figure 3. Mean score of self-regulation aspect

The results of N-Gain habits of mind calculation based on initial and final measurements are in the moderate category (0.31). These data indicate that the habits of mind of students have increased quite well. Based on these facts it can be interpreted that the developed learning program had a positive impact on the development of student Habits of Mind.

Specifically the results of the Habits of Mind measurement can be described based on their respective aspects. The measurement results in the first aspect (self-regulation) are explained in Figure 3.

Based on the data in Figure 3, it is shown that overall the average score of the self-regulation aspect has developed from the initial condition (2.76) and the final condition after being given the learning program (3.42). More detailed Figure 3 describes the condition of student Habits of Mind per indicator. The three Habits of Mind indicators on the aspect of self-regulation (make effective plans; are aware of and use the quality of resources; and sensitive to feedback) all show good progress. However, of the three highest scores are the “makes effective plans” and “is aware of and uses necessary resources” indicator. This fact can be interpreted that students become more skilled in planning before doing work and have better knowledge on the resources needed to support their work.

The second aspect of the Habits of Mind standard measured in this study is critical thinking. The condition of the development of habits of mind from this aspect is explained in Figure 4.

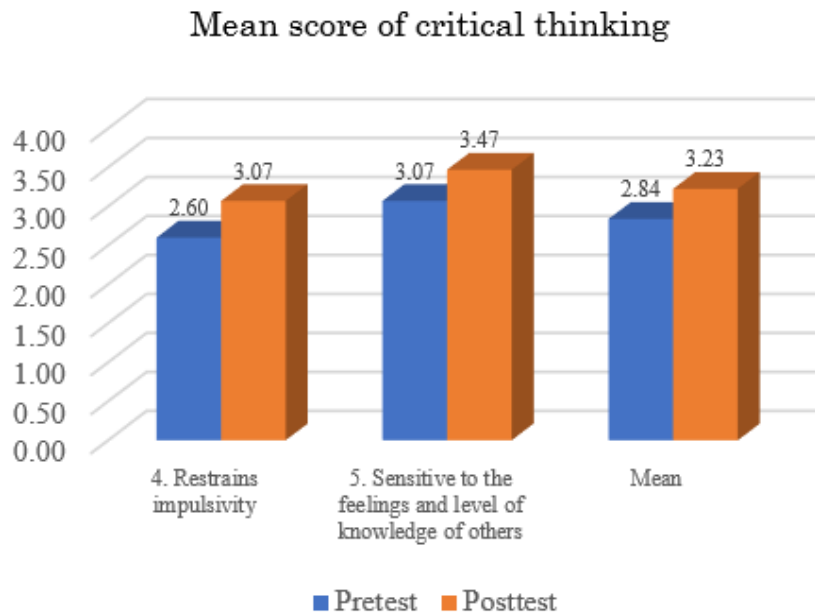


Figure 4. Mean score of critical thinking

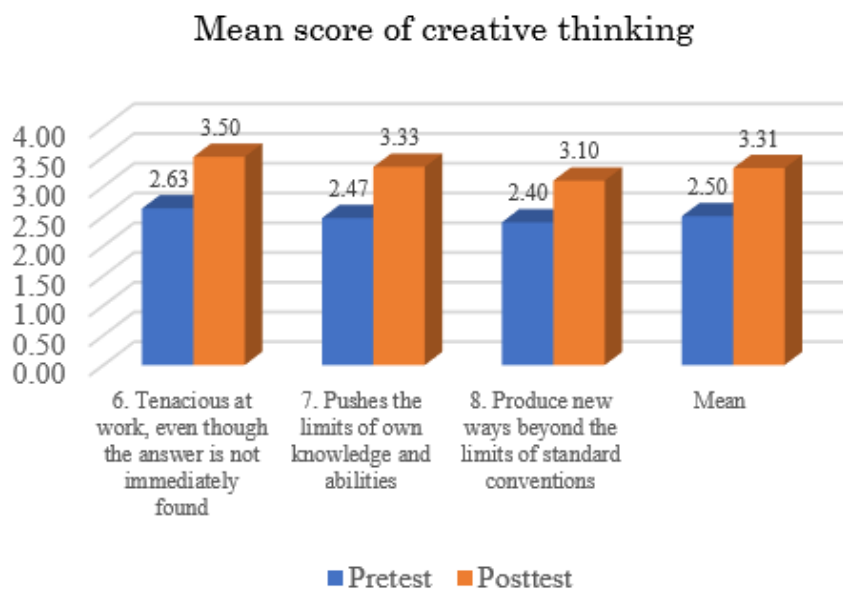


Figure 5. Mean score of creative thinking

Figure 4 illustrates the development of the students' Habits of Mind condition which is shown in the aspect of critical thinking, that is the initial condition shows a score of 2.84, while the final condition after being given the learning program becomes 3.23. These developments are also shown by each indicator in this aspect. However, from the two indicators that showed the best development were indicators "sensitive to feelings and level of knowledge of others", that is the final score of 3.47; while the indicator "impulsivity restrains" final scores only 3.07. That is, during the learning process the students have practiced become more sensitive to the feelings and level of knowledge of others. This condition is evidenced by the habits of students in discussing and presenting their work in the classroom become more careful in expressing their opinions, showing each other respect and mutual respect.

The third aspect of Habits of Mind is creative thinking. There are three individuals in this aspect, and all of them show positive developments. More detailed description of the students' Habits of Mind conditions on the creative thinking aspect is explained in **Figure 5**.

Table 1. Data on the development of habits of mind at each stage of learning

No	Aspect	Stage of Inquiry 5E+e			
		Stage I	Stage II	Stage III	Stage IV
Self-regulation					
1	Makes effective plans	3.05	2.77	3.42	3.68
2	Is aware of and uses necessary resources	3.20	3.22	3.58	3.77
3	Is sensitive to feedback	3.13	3.30	3.46	3.54
Mean Score		3.13	3.10	3.49	3.66
Critical Thinking					
4	Restrains impulsivity	2.94	2.67	3.12	3.34
5	Sensitive to the feelings and level of knowledge of others	3.07	3.37	3.49	3.48
Mean Score		3.01	3.02	3.31	3.41
Creative Thinking					
6	Tenacious at work, even though the answer is not immediately found	3.00	3.27	3.76	3.86
7	Pushes the limits of own knowledge and abilities	3.32	3.19	3.34	3.71
8	Produce new ways beyond the limits of standard conventions	3.13	2.84	2.93	3.33
Mean Score		3.15	3.10	3.34	3.64
Total Mean		3.09	3.07	3.38	3.57

On average the data shown in **Figure 5** illustrates the development of students' Habits of Mind in the very creative aspect of creative thinking, that is the initial score of only 2.50 and the final score after being given a learning program reaching 3.31. The development of this value is the highest compared to other aspects, although the final score is still higher in the aspect of self-regulation. This condition is interpreted that during the learning processes, the program developed can improve students' creative thinking skills well. After being given a program developed, students become more resilient and have a spirit of never giving up, able to think up to the limits of their habits and knowledge, and are able to produce new ways above standard conditions.

The analysis is relevant to several findings from the results of previous studies. Pedagogical approaches play an important role in students' creative thinking and behavior, and effectively motivates them to actively participate in teamwork, and is able to generate new value for their team (Gundry et al., 2014). Students who consider themselves to have a higher perception of creativity have a higher tendency to learn, and creative individuals also value their learning outcomes as positive things, both benefits and ease of use that they feel (Lourenc & Jayawarna, 2011). High scores on a creativity test and prior entrepreneurial experiences are positively associated with entrepreneurial intentions, whereas perception of risks has a negative influence (Hamidi et al., 2008).

Development of Habits of Mind students at each stage of learning

Development of Habits of Mind data that has been shown in point 1 collected through a questionnaire has been strengthened by the results of observations made throughout the learning process at each stage. Data on the development of students' habits of mind at each learning stage are described in **Table 1**.

The data in **Table 1** illustrates that on average the students Habits of Mind showed progress from stage I to stage IV, i.e. stage I (3.09), stage II (3.07), stage III (3.38), and stage IV (3.57). Especially in stage II the mean score of students' habits of mind had decreased. That is because in II the results of their experiments had failed, thereby reducing their motivation to learn. However, before entering stage III students are motivated again by the lecturer and directed towards their learning orientation. Thus, in stages III and IV the development of habits of mind of students continues to experience rapid development. Likewise, the data on the development of Habits of Mind shown in each of its aspects, all three aspects show significant development. Based on the data in **Table 1** shows that every aspect of Habits of Mind is developing, but of the three that most show development is the aspect of self-regulation, i.e. stage I (3.13), stage II (3.10), stage III (3.49), and stage IV (3.66).

The facts shown in **Table 1** interprets that between the data collected through observation is in line with the data collected through a questionnaire. Both of them showed the same data, namely the Habits of Mind of the students had increased after being given treatment. These conditions indicate that the 5E+e inquiry learning program applied to horticulture courses successfully trains critical thinking, creative thinking, and student self-regulation. Specifically, it can also be analyzed that the aspect of Habits of Mind which shows the



Figure 6. Some of the activities carried out in the horticulture course with the 5E+e inquiry

highest increase is self-regulation. This fact indicates that the 5E+e inquiry learning program applied to the horticulture course successfully trains students' skills in planning before doing work, realizes the need for resources to support their work, and is sensitive to feedback given by anyone.

Some analyzes that can be explained are related to the findings of this research data, including: first, many horticultural lectures involve students in conducting plant cultivation with various planting techniques. The planting technique used is adapted to several conditions, such as the type of plant, the adaptive nature of the plant, the availability of soil, and the state of the growing media. In addition, market demand for horticultural products, especially modern horticulture is increasing, for example, such as hydroponic vegetables (see **Figure 6**). This experience encourages students to think creatively in creating good horticultural products in accordance with market demand, even thinking to the maximum extent of their knowledge and abilities.

Second, the horticulture course with the 5E+e inquiry program have provided students with experience in conducting planting trials with a variety of planting techniques, from the seed phase to harvesting. During the planting process monitoring is always carried out on the growth and development of the cultivated plant, the factors that influence it, as well as the nutritional needs of the plant. The activity has provided students with critical thinking in facing problems. Students are always careful in observing the growth and development of plants, not being impulsive in every action, and always careful in drawing conclusions from the results of their investigations.

Third, the horticulture course with the 5E+e inquiry program is carried out in a planned and systematic manner, especially in trials of plant cultivation, starting from the seed phase, maintenance and nutrition, to the harvest phase. All activities are carried out strictly and reduce errors. This is not easy to do if you do not have a persevering and patient soul, especially when the planting experiment is failing. If you experience this condition, then the right solution must be found immediately and not panic. This experience has trained students to always make good planning before doing work, realize and know the resources needed to support their work, and be sensitive to the feedback given by others.

Some previous studies reported that students' Habits of Mind improved well in selective biology courses through learning which gave many conceptual problems to students (Gloria, 2017). Students' Habits of Mind develop well after being given formative assessment intensively during learning, students are given feedback, self assessment and peer assessment regularly (Sriyati, 2010). Other research states that course programs on

Marzano's learning dimensions based plant anatomy can improve students' quantitative literacy and Habits of Mind (Nuraeni et al., 2015). Likewise with Gloria et al. research, 2017, that students' habits of mind have increased after being given formative assessment with stages of Understanding by Design (UbD).

On a different side, a study analyzed published articles about the application of entrepreneurship education at the University. The results of his studies show that most entrepreneurship programs at universities still focus on efforts to encourage entrepreneurial intentions through mainstream training and knowledge. There is no strategy that is sufficiently relevant to the conditions of the field (market labor, identifying business opportunities with growth potential, expansion of market size, available financial resources), which often makes new entrepreneurs become discouraged (Valencia-Arias et al., 2018).

The results of these studies become recommendations in this study to create representative learning programs to integrate entrepreneurship in the science education curriculum, especially in improving students' habits of mind. Therefore, this study designed an inquiry learning program with entrepreneurship orientation (5E+e) in biology learning.

CONCLUSION

The habits of mind of prospective biology teachers have improved well during Horticulture lectures with entrepreneurship-oriented inquiry learning programs. This fact is proven by the results of initial and final measurements through a questionnaire filled out by them. In addition, the data is supported by observations during learning in four stages. Of the three aspects of habits of mind measured in this study (self-regulation, critical thinking, and creative thinking) all showed an increase with good, but aspects of self-regulation showed the highest increase. That is due to the learning programs applied to horticulture course provides lots of experiences for prospective biology teachers to make work plans better, realize the need for resources to support their work, and are more sensitive to feedback from others.

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Disclosure statement

No potential conflict of interest was reported by the authors.

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