

## The effect of ethnobotanic activities on learning performance of pre-service teachers about plants' classification

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### Abstract

This study analyses the effectiveness of ethnobotanic activities on learning performance of pre-service teachers about plants' classification. The research design was a quasi-experimental model. The results of the study revealed that the experimental group in which ethnobotanical activities were carried out was more successful for answers given to the interview form. On the other hand, there was no difference between the groups in multiple-choice questions. In other words, ethnobotanical practices have developed the subjective views of the students so they could have more comprehensive knowledge of the plants. These results suggest that ethnobotanic activities encourage pre-service teachers to think and talk through how to solve more open-ended problems that require making connections between analytical and practical components. This study also suggests the need to rethink how we teach botany to pre-service teachers, and how to help them learn the content better and establish more accurate conceptions of the biology content.

**Keywords:** Ethnobotanic activities, learning performance, pre-service teachers.

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## 1. Introduction

The teaching of biology (general biology, botany and zoology) is devoted mainly to the transmission of currently accepted knowledge and places little emphasis on building scientific procedures (Martins, 2009). This view of teaching has been heavily criticised for its fragmented approach, with the aim of being memorised (Selles & Ferreira, 2005). This approach to biology course content lacks proper contextualisation and raises difficulties in learning the core concepts of biology (Meghioratti, Brando, Andrade & Caldeira, 2009). Generally, the teaching of botany is seen as mainly based on the transmission of knowledge and on empirical-logical thinking, in a context of scientific knowledge with the purpose of affirming the truth about the world (Guimaraes, 2005).

This study investigates learning performances of pre-service teachers using ethnobotanic-based activities compared to pre-service teachers using the National Curriculum (conventional-teaching-based). To this end, the study was guided by the following research questions:

- a) What do pre-service teachers learn about the plants' classification in ethnobotanic activities in contrast to a conventional teaching method?
- b) How do the characteristics of these curricula support pre-service teachers' ability to learn about the plants' classification and help them develop accurate biology conceptions?

### 1.1. Conceptual design framework

Many students first learn their environment and plants through similar experiences to the activities carried out in the school. As revealed by Skelly and Zajicek (1998, p. 582), 'This is important because many researchers believe that schools are the instruments to teach environmental education'. In addition, it should be kept in mind that many teachers are inadequate in organising of appropriate learning environments for their students and in teaching of environmental concepts (DeMarco, Relf & McDaniel, 1999).

Nowadays, the most common teaching approach is a method of lecturing in which information is transferred to the student by the teacher. The information is organised, classified and presented systematically by the teacher. Most teachers think that the subject becomes clear enough by lecturing the botanical contents (Busato, 2001). In a study conducted with primary school students, the students were asked how the teaching should be. These students stated that experiments, observations and trips to museums and natural environments should be done without thinking about the concepts of botany (Caldeira, 2009). Regarding the teaching of botany; Silva, Cavassan and Seniciato (2009) listed the subjects separately for primary and secondary school. In addition, the researchers stated that scientific names were completely isolated from reality in their teaching process and they experienced difficulties in understanding the botanical concepts of students.

Botany teaching is now a field of interest for many sectors (health, agriculture and so on) other than education (Guimaraes, 2005; Kinoshita et al., 2006; Senciato & Cavassan, 2004; Silva, Cavassan & Seniciato, 2009; Towata, Ursi & Santos, 2010). On the other hand, botany teaching is still quite theoretical; thus, it prevents the development of students' thinking skills. Therefore, it can be argued that biology and science education have been neglected in the teaching processes (Kinoshita, Torres, Tamashiro & Forni-Martins, 2006). In this context, the term ethnobotany has been put forward to reveal the socialisation of teaching instead of being theoretical. This concept, first put forward with archaeological research by John Harshberger (1896) at Mancos Canyon in Colorado (USA), brought a different understanding to the botanical culture. Ethnology consisted of the words *ethnos* (nation) and *logos* (science) as a branch of science dealing with the distribution of different groups of people, the relations and activities. Since the early 1990s, interest in ethnobotany has increased; however, it is still difficult to do ethnobotanical research in developing countries. This depends on the traditional approach that is being implemented in that country. Why is the ethnobotany so important then? In

fact, the answer to this question is found in many ecological texts. When an energy pyramid is examined, plants are located in a very important field. This requires a more conceptual understanding of plants. In the words of Smith (1995), 'Ethnobotany is the sum of human subsistence knowledge'. The concept of ethnobotany specifically evaluates the relationships of plants with humans seeking to obtain food, fiber, medicine, paint and tools.

Although ethnobotany is increasingly recognised as an important issue for sustainable development, there is quite inadequacy in the placement of the understanding in teaching processes (Hamilton, 2003, p. 1). This can be attributed to the lack of an appropriate ethnobotanical curriculum module. Ethnobotanical learning is based on specific instructional insights. These include learning by doing, experiencing multiple data, synthesising the obtained data, considering subjectivity instead of objectivity, collecting works used by people living in the region, preparing herbarium samples, learning by demonstration, learning by collecting information from local people, learning to write field research, writing research proposal, creating an end-of-term report and participating in presentations. In this method, students get to know the plants around them better and they become aware of their ecology. The learners work in small heterogeneous groups to obtain interesting facts and stories about plants from people in the community.

Ethnobotanical activities do not refer to a working process in which students sit in the classroom (Mudaly, 2018). Instead, students go out from class and conduct research studies according to the instructions. They ornament their studies with photographs, pictures, interviews and add value. Students are necessarily required to attend the dialogue and visit their environment within an ethnobotanical study (Yangin & Dindar, 2015). Attitudes towards the environment and living in nature cannot be developed by sitting in classes. Learners examine their surroundings with ethnobotany applications. However, the students go online and other libraries to do research about plants and write about them (Salan et al., 2017). They find historical events related to plants, and working together, they create a timeline of significant world events related to plants (Harrell & Forney, 2001).

It is important to consider the misunderstandings of pre-service teachers about biology, especially botanic concepts. In fact, if teachers have erroneous and limited content, they cannot be aware of the alternative learning of their students. Therefore, teachers' presentation with scientifically accepted explanations to their students may lead to academic errors in this regard. It is quite likely for students to make false statements when explaining botany through the presentation. Teachers' own alternative concepts about botany can prevent students from developing correct insights (Osborne & Simon, 1996; cited. Murphy & Smith, 2012: 79). It can be said that the amount of mislearnings related to the biology course is very high and it is one of the courses that pose difficulty for students. There are several studies conducted with pre-service teachers (Adeniyi, 1985; Boyes & Stanisstreet, 1991; Griffiths & Grant, 1985; Stewart & Dale, 1989; Tekkaya, Sen & Ozden, 1999; Yangin, 2013; Yangin, Sidekli, & Gokbulut, 2014). In most of these studies, the alternative learning of the pre-service teachers about the plants was determined and presented in a descriptive format.

Nowadays, education is rapidly growing and thus we have to educate people who have critical and logical thinking and problem-solving faculties together with socially developed features. This will be available with a high quality education that uses teaching methods and technologies (Lappan, 2000). Studies show that students' academic achievements and abilities in making generalisations and solving problems improve learning-by-doing and learning-by-living. In particular, in biology lessons that are considered difficult to learn, it is possible that the success of the students can be upgraded if different teaching methods are used by the teachers. In this context, ethnobotany applications known by biologists are used. In this study, the effects of 'ethnobotanic-based activities (project and cooperative-learning-based)' on pre-service teachers in botany education are analysed in relation to their learning performances. There was found no previous scientific-educational study on this topic. This paper presents a study on pre-service teachers from two universities in order to demonstrate their learning performance levels related to plant concepts.

## 2. Methodology

The study was carried out with a mixed methodological approach in order to find out how ethnobotanic-based biology activities may improve pre-service teachers' content understanding and help them establish their conceptual framework for the content. The research design was a quasi-experimental design. Identical written tests and interviews were conducted before and after instruction to both the experimental and the control groups. Pre-service teachers from two state universities participated as the control group and the experimental group. The experimental group was taught with ethnobotanic-based learning design. This study was conducted in the Eastern Black Sea Region of Turkey. This part of the country is famous for plants and various types of alga common to humid places such as tea, corn, hazelnuts, black cabbage and kiwis. For this reason, the main purpose of the study was to collect information from pre-service teachers about these plants based on the teaching principles.

### 2.1. Research procedure

The research was designed in a quasi-experimental research model. The process model of the study is given in Table 1. In this table, the control and the experimental groups, treatment and pre- and post-measurements are shown. The control group included first-grade pre-service teachers from the university, whereas the experimental group consisted of the first-grade classroom teaching pre-service teachers from the same university.

**Table 1. The design of the study**

Group	Pre	Treatment	Post
Control Group	T <sub>1</sub> T <sub>2</sub>	X <sub>1</sub>	T <sub>1</sub> T <sub>2</sub>
Experimental Group	T <sub>1</sub> T <sub>2</sub>	X <sub>2</sub>	T <sub>1</sub> T <sub>2</sub>

T<sub>1</sub> represents the written form while T<sub>2</sub> represents the interview. X<sub>1</sub> stands for teaching of 'Living World: Plants', Council of Higher Education National General Biology Course Teaching curriculum, (*the classification and the diversity of plants issue*), while X<sub>2</sub> refers to the ethnobotanic-based design on 'Living World Unit: Plants'.

### 2.2. Data sources and data collection

In this study, data were collected using multiple measurement tools. For this purpose, a written test and interview form was used. Despite not being included in the analysis, class observations and diaries were counted in during the formation of the comments. In this way, it was revealed how ethnobotany-based practices affect pre-service teachers' learning about the systematic of plants. In addition to the ethnobotany understanding, the learning outcomes of the pre-service teachers in two different measurement tools were evaluated for curriculum-based activities. It was planned to better understand the level of science knowledge learnt by pre-service teachers from multiple sources. Also, it was thought to shed light on approaches that are more effective for learning the content of science. Therefore, this study focused on the data collected through two different channels such as written tests and interviews.

#### 2.2.1. Written test

In this study, the same written form was applied as pre- and post-test in order to measure the learning achievement of pre-service teachers about the plant world (see Appendix A.1.). The written form used as pre- and post-test consists of six multiple-choice and five open-ended questions. The questions in the test were developed by the researcher. For this test, a preliminary study was performed in a separate sample, and the instrument was found valid and reliable. The form was optimised for in-class and inter-class comparison before the final version was reached. In the written

form, questions related to the purpose of the unit were included to cover all types of learning (e.g., creative, practical, analytical and memory assessment). The questions were read, edited and ordered by three researchers (one biologist, one language educator and one measurement and evaluation expert). The feedback of the academicians about the difficulty level of the questions continued after the pilot implementation. The pilot study was applied to 12 students who were studying in the classroom teaching programme but they were excluded from the study. Three researchers reviewed the questions in an independent and unannounced manner. In this assessment, the questions were reviewed for (a) difficulty level, (b) the type of cognitive learning (analytical, practical, memory and creative) and (c) the relevant target(s). Questions that could not be compromised were either completely deleted, or edited and re-evaluated. This phase continued until a common consensus was reached. The written exam was used to evaluate understanding and learning about plants of the pre-service teachers in both experimental and control groups.

### **2.2.2. Interview**

An interview form was developed in this study in order to find out how pre-service teachers acquire their deep understanding of vegetation and how they construct this knowledge and how they make sense of the concept of the plant (see Appendix A.2.). The draft interview form was applied to a different sample like the written test. The suitability of the questions was evaluated. In addition, conformity to the written form was ensured. For example, the second open-ended statement within the written form dealt with the phenomenon similar to the third item in the interview form. However, the purpose of the interview form is to make students explain the same phenomenon in more detail. The interview form was submitted to the evaluation of three researchers. The criteria in the previous section were also taken into consideration here. Unsuitable questions were omitted or edited. The final interview form consisted of five main questions and sub-questions. The interviews were conducted with 46 students as it was not possible to interview with 104 pre-service teachers. In other words, interviews were conducted with the students who participated voluntarily. The interviews were video recorded. The pre-test and the pre-interviews were conducted before the instruction, and the post-test and the post-interviews were conducted within 3 weeks following the conclusion of the teaching unit '*the classification and the diversity of plants*'.

## **2.3. Study context**

### **2.3.1. The experimental group**

During the 2017–2018 academic year, Recep Tayyip Erdogan University was selected as the experimental school. An academician implemented the ethnobotanic-based unit of teaching. The two first-grade classes in this university participated as experimental classes. During the year in which this study was conducted, the university had the following demographics: 54.6% girl and 46.4% boy. Also, the university had pre-service teachers living in the town centre (65.9%), county seat (29.8%) and villages (4.3%).

The ethnobotanic based out-of-class unit '*the classification and the diversity of plants*' was used as an activity. The unit of teaching was developed for first-graders by the researcher. It includes eight lessons, each lesson covering a 50-minute period. One of the two academicians taught the unit on biology to both of the classes in the experimental university. Pre-service teachers were enrolled in class with 25 boys and 43 girls in each.

There are two first-grade classes in the university. The lessons on classifications and plants and the final ethnobotanic lessons were observed and videotaped. The pre-test and the pre-interviews were conducted before instruction, and the post-test and the post interviews were conducted within 3 weeks after the completion of the unit concerned.

### 2.3.2. The comparison university

The comparison university (called Trabzon University) is in the Black Sea District as the comparison university. One of the two biology courses was taught by academicians via the official General Biology course teaching curriculum. The two first-grade classes in this university participated as comparison classes. During the year of research, the university had the following demographics: 51.3% girl and 48.7% boy. Apart from that, the university had pre-service teachers living in the town centre (69.4%), county seat (24.6%) and villages (7%).

### 2.4. Data analysis

This study was designed as a quantitative analysis. Quantitative values were used for both the written test and the interview form. For this purpose, a rating scale was developed for the pre-service teachers' answers to the written test and the interview questions. This scale was used for open-ended questions and interview questions in the written test. However, the open-ended items in the written test were graded as 0-1-2 (sufficient: 2, partially sufficient: 1 and inadequate: 0), while those in the interview form were graded as 0-1-2-3 (very sufficient: 3, sufficient: 2; inadequate: 1 and very inadequate: 0). However, for every multiple-choice question that takes into account objective reality and has a single correct answer, the pre-service teachers scored from 0 to 1. The written test questions were reviewed by three experts. In this context, the inter-rater reliability value was obtained as 0.86. Among the experts, the desired fit score should be greater than 0.80 (Fraenkel & Wallen, 1993). As a result, the ratings can be said to be reliable in our case (Table 4).

**Table 2. The scoring table for the written test items**

	1	2	3	4	5	6	7	8	9	10	11
Type	MC	MC	OE	OE	MC	MC	OE	MC	MC	OE	OE
Score	0-1	0-1	0-1-2	0-1-2	0-1	0-1	0-1-2	0-1	0-1	0-1-2	0-1-2

MC: Multiple-choice; OE: Open-ended.

The scoring table is shown in Tables 2 and 3 for the written test and interview items. In the written test questions 1, 2, 5, 6, 8 and 9; respondents get 0 when they choose a wrong answer and 1 when they choose a correct answer. In other questions, pre-service teachers get 0.5 for definition, classification, using of the plants and drawing the plants.

**Table 3. The scoring table for the interview items (IE)**

Question	1	2	3	4	5
Answer	Using of ethnobotanic plants	Seedy and seedless plants	Sub-categories of seedy and seedless plants	Ethnobotanic purpose	Gymnosperm and Angiosperm
Score	0-1-2-3	0-1-2-3	0-1-2-3	0-1-2-3	0-1-2-3

0: Completely inadequate; 1: Partially insufficient; 2: Partially enough; 3: Completely enough.

For the open-ended questions in the written test, pre-service teachers can get 0, 1 or 2 points for their answers. They get 0 in the case of a totally wrong answer, no answer or an irrelevant answer. For example, in question 8, pre-service teachers get 1 if they only discuss the sections of seedy or seedless plants in a way that is not fully accurate, still referring to seedy-seedless plants. However, they get 2 if they discuss seedy or seedless plants using the visual graphics. In questions 3 and 7, pre-service teachers get 1 if they give a correct answer for only one of the two parts of the question, each part having the value of 1 point. Thus, they can get 2 points if both parts are answered correctly. In question 4, respondents who classify seedless and seedy plants in samples get 1 point, but those who provide an explanation for classification by using seedless and seedy plants get 2 points. In question 10, pre-service teachers get 0 if their drawings include a seedy and seedless plant, which is not shaped or is shaped incorrectly. Pre-service teachers' whose drawings include a seedless and seedy plant

which could be used in a way and is correctly shaped, get 2. In question 11, pre-service teachers get 0.5 for each seedless and seedy plant labelled correctly up to four samples.

When it comes to the interview questions, pre-service teachers can get 0, 1 or 2 points for their answers. Pre-service teachers get 0 if they give a totally wrong answer, no answer or an irrelevant answer. However, they get 1 if their answer reflects a confused, incomplete or inaccurate understanding of the plant. Moreover, 2 points are given if their answer reflects a partial understanding of the plant. As the highest point, they get 3 if their answer reflects a complete understanding of the plant. Two types of measurement tools were used for the pre-service teachers. Multiple-choice test (MC) and open-ended items (OE) in one test and interview form (IE). The written test included open-ended questions with multiple-choice questions. For these types of questions, evaluations were made according to the rating score (Table 2). The interview form came down to the details of the content information and consisted of semi-structured questions. In this form, a rating criterion was developed (Table 3) and quantitative scores were given to pre-service teachers. The content interview form was applied to 46 out of 104 pre-service teachers. Forty-six pre-service teachers took part in the interviews on a voluntary basis.

**Table 4. Inter-rater scoring agreement percentages for the open-ended test items and the interview items**

Open-ended items	Percent agreement	Interview items	Percent agreement
Item 3	82.65%	Item 1	82.45 %
Item 4	82.54%	Item 2	82.48 %
Item 7	81.24%	Item 3	84.26 %
Item 10	81.21%	Item 4	86.71 %
Item 11	86.26%	Item 5	84.23 %

The pre-service teachers' responses to the open-ended items in the written test were also scored by the two experts. The experts scored about one-third of all forms. The average of the scores of the experts and the quantitative results of the researcher were compared. As a result, the agreement percentages of the open-ended items and the interview clauses were established as seen in Table 4. According to Table 4, the average percentage of total agreement for both open-ended items and interview items was found to be 81.7%. This percentage indicates a consensus in all items. Thus, one expert continued to score the remaining forms. The scores were used for statistical analysis.

**Table 5. Areas of investigation, data sources to be used and the analysis that were made to answer the questions**

Areas of investigation	Data sources	Analysis
<i>What do pre-service teachers learn in regard to plants in ethnobotanic activities and constructivist approach of the official teaching curriculum of biology lesson?</i>	Written Tests	Pre MC – Post MC → Paired t-test
		Pre OE – Post OE → Paired t-test
		Pre Int – Post Int → Paired t-test
<i>How do the curricular characteristics support pre-service teachers in learning biology content and support pre-service teachers in changing their misconceptions?</i>	Interviews	Match Analysis
	Written Tests	Post MCCont – Post MC Exp → ANCOVA
		Post OECont – Post OE Exp → ANCOVA
Interviews	Post IntCont – Post Int Exp → ANCOVA	
	Effect Sizes	

MC: Multiple-choice; OE: Open-ended; Int: Interview; Cont.: Control group; Exp.: Experimental group.

Table 5 shows the areas of investigation, the data sources to be used and the analyses that were used to answer the questions. To investigate the impact of ethnobotanic-based biology activities

compared to 'National General Biology Teaching Curriculum' on pre-service teachers' learning performance, a comparison was performed on the control and the experimental groups' scoring on the tests and the interviews. An Analysis of Covariance (ANCOVA) test was run and the pre-scores constant (they become a covariant) was held on SPSS 20.0. To investigate what pre-service teachers learned in each of the two activity areas, their scores were compared for each item in the written tests and the interviews before and after the ethnobotanic instruction by running match analysis on SPSS 20.0.

### 3. Results and discussion

#### 3.1. Written test

##### 3.1.1. Multiple-choice items

The effect-size correlation was calculated for the post scores of the two groups on the multiple-choice items. The effect-size correlation,  $r$ , equals to 0.1648, which denotes a very low correlation between the post scores of the two groups on the multiple-choice items.

3.1.1.1. ANCOVA-Group (*ethnobotanic-based vs curriculum-based*). In this study, multiple-choice items in the written test were analysed in the first stage. The main aim of the study is to compare the ethnobotany understanding of activities based on ethnobotany understanding with the conventional activities in terms of learning success in the systematic and diversity of plants. In other words, the aim of this research is to evaluate the learning of plants in the biology course by using two different activities. For the purpose of this study, pre-service teachers were given the opportunity to make explanations and comments on the test. In this context, the effect value of the ethnobotanic-based and the conventional-based curricular units was calculated separately by carrying out covariance analysis on the final scores of the multiple-choice test. For ANCOVA, the group was predicted as a fixed factor. Pre-test scores of multiple-choice items were also covariant. ANCOVA analysis in the study is shown in Table 6.

**Table 6. ANCOVA results with 'MCPostSum' as the dependent variable, 'MCPreSum' as the covariate, and 'group' as the fixed factor**

Source	Sum of squares	df	Mean of squares	F	p
Corrected model	3.653 <sup>a</sup>	2	1.791	1.768	0.164
Intercept	154.817	1	154.817	157.485	0.000**
MCPreSum	1.713	1	1.713	1.542	0.187
Group	2.087	1	2.087	1.974	0.120
Error	77.421	101	1.046		
Total	926.087	104			
Corrected total	82.274	103			

R squared = 0.045 (Adjusted R Squared= 0.020); \*\*  $p < 0.001$ .

The results were not statistically significant for the effect of MCPreSum covariant ( $F = 1.542$ ;  $p = 0.187$ ) or the effect of group ( $F = 1.974$ ;  $p = 0.12$ ) at  $p < 0.01$  level. These findings did not significantly affect the achievement of the ethnobotany understanding of the diversity of plants according to the analytical learning of pre-service teachers. Analytical learning is evolving from building meaningful relationships between parts by fragmenting the whole. However, it is quite common for the results of the multiple-choice test which takes into account the objective reality. Ethnobotanical practices focus on the subjectivity of knowledge as opposed to objectivity because the information is being built with multiple sources (social media, society, films, expert interviews, etc.) instead of the textbook. On the other hand, in all classical test forms that take into account the realities of knowledge, although there is a higher average score in the control group, other measurement tools should be taken into account for the control of the development of the high-level thinking. Therefore, multiple-choice tests were not used alone in this study.

3.1.1.2. *Paired t-tests*. In this study, t-test was applied to the pre-test and post-test control of the control and experimental groups except ANCOVA analysis. The pre-test total scores and the post-test total scores of the pre-service teachers in both groups were compared for the same item. In addition, the pre-test and post-test scores of the pre-service teachers were matched with the other group colleagues. The results of this paired t-test are shown in Table 7.

**Table 7. Paired differences in pre-service teachers' scores on multiple-choice items**

Combined Pairs	N	$\bar{x}$	SD	SEM	t	p
MCpre Exp – MCpost Exp	68	0.924	1.32	0.181	5.24	0.000**
MCpre Cont – MCpost Cont	36	1.23	1.67	0.347	3.75	0.001**

\*\* $p < 0.001$ .

The paired t-test results indicated that in both the experimental group ( $t = 5.24$ ;  $p = <0.001$ ) and the control group ( $t = 3.75$ ;  $p < 0.001$ ), pre-service teachers' scores on multiple-choice items increased significantly. In addition, the effect-size correlations were calculated for the first and second pairs. The effect-size correlation,  $r$ , values for both the MCpre Exp–MCpost Exp pair (where  $r = 0.4024$ ) and the MCpre Cont–MCpost Cont pair (where  $r = 0.4203$ ) were in the medium high range.

**Table 8. Pre and post mean scores of pre-service teachers from both the control and the experimental groups on multiple-choice questions**

Groups	Pre-test scores (Mean)	Post-test scores (Mean)
Control	2.21	3.42
Experimental	2.23	3.36

When the scores of the experimental and control groups were compared as regards to the multiple-choice items in the test, it was seen that the control group had a higher score. In the experimental group, the pretest mean score was 2.23, the posttest score was 3.36, and the pre-test score was 2.21 and the posttest average was 3.42. This difference was not found meaningful.

### 3.1.2. Open-ended items

The effect-size correlation was calculated for the post scores of the two groups on the open-ended items. The effect-size correlation,  $r$ , was 0.1476, which denotes a very low effect between the post scores of the two groups on the open-ended items.

3.1.2.1. *ANCOVA-Group (ethnobotanic-based vs. curriculum-based)*. In this part of the study, the effects of ethnobotany-based practices and curriculum-based activities on the scores of the pre-service teachers in the open-ended items of the written test were tested.

In this context, the group (the ethnobotanic-based or the curriculum-based activities) effect value of the ethnobotanic-based and the conventional-based curricular units was calculated separately by carrying out covariance analysis on the final scores of the open-ended items. For ANCOVA, the group was predicted as a fixed factor. Pre-test scores of open-ended items were also covariant. ANCOVA analysis in the study is shown in Table 9. The results were not statistically significant for the effect of group ( $F = 0.624$ ;  $p = 0.326$ ) at  $p < 0.01$  level. However, the effect value of the OEPreSum covariant ( $F = 17.653$ ;  $p = 0.000$ ) is significant at  $p < 0.001$  level. These findings did not significantly affect the achievement of the ethnobotany understanding about the diversity of plants according to the practical learning of pre-service teachers. On the other hand, a relationship was seen between the first and last scores of the pre-service teachers on the open-ended items.

**Table 9. ANCOVA results with 'OEPostSum' as the dependent variable, 'OEPreSum' as the covariate, and 'group' as the fixed factor**

Source	Sum of squares	df	Mean of squares	F	p
Corrected Model	57.584 <sup>a</sup>	2	28.265	9.893	0.000**
Intercept	387.218	1	387.218	139.875	0.000**

MCPreSum	48.265	1	48.265	17.653	0.000**
Group	1.764	1	1.764	.624	0.326
Error	211.248	101	1.883		
Total	2102.076	104			
Corrected Total	254.093	103			

R squared = 0.224 (Adjusted R Squared = 0.204); \*\* $p < 0.001$ .

3.1.2.2. *Paired t-tests.* In this study, t-test was applied to the pre-test and post-test comparison of the control and experimental groups except ANCOVA analysis for open-ended items. The pre-test total scores on open-ended items and the post-test total scores of the pre-service teachers in both groups were compared for the same item. In addition, the pre-test and post-test scores of the pre-service teachers were matched with the other group colleagues. The results of this paired t-test are shown in Table 10.

**Table 10. Paired differences in pre-service teachers' scores on open-ended items**

Combined pairs	N	$\bar{x}$	SD	SEM	t	P
OEpre Exp–OEpost Exp	68	2.90566	1.78820	0.24563	12.756	0.000**
OEpre Cont–OEpost Cont	36	2.79808	1.69118	0.33167	7.868	0.000**

\*\* $p < 0.001$ .

The paired t-test results indicated that in both the control group ( $t = 7.868$ ;  $p < 0.001$ ) and the experimental group ( $t = 12.756$ ;  $p < 0.001$ ), pre-service teachers' scores on open-ended items increased significantly.

**Table 11. Pre and post mean scores of pre-service teachers from both the control and the experimental groups on open-ended items in written test**

Groups	Pre-test scores (Mean)	Post-test scores (Mean)
Control	2.16	4.34
Experimental	2.11	5.28

The experimental group had a score of 2.11 on the pre-test and 5.28 on the post-test, while the control group had lower mean scores as 2.16 on the pre-test and a greater mean score as 4.34 on the post-test (Table 11). In this context, it is possible to say that the experimental group pre-service teachers are more successful than the control group according to the values obtained from the pre-test and post-test open-ended questions.

In addition, effect-size correlations were calculated for both the first and the second pairs. The effect-size correlation values,  $r$ , for both the OEpre Exp–OEpost Exp pair as  $r = 0.6338$  and the OEpre Cont–OEpost Cont pair as  $r = 0.6124$  were on the medium high range. In other words, ethnobotanical activities were more effective on the experimental group when open-ended questions were considered.

### 3.2. Interview form

The effect-size correlation,  $r$ , for the post scores of the two groups on the interview items was found to be 0.42 (Cohen's  $d$  equals 1.05), which indicates a medium effect between the post scores of the two groups.

#### 3.2.1. ANCOVA-Group (ethnobotanic-based vs curriculum-based)

The main objective of the ANCOVA test on the experimental and control groups is to compare the practices of ethnobotanical understanding and the curriculum-based activities in relation to students' answers to the questions in the interview form. The last interview scores of pre-service teachers were analysed separately and the effect value of each group (ethnobotanical understanding and curriculum

understanding) was calculated. In terms of ANCOVA, the group was predicted to be a fixed factor and the final scores in the interview items were evaluated as covariate. The results obtained from the ANCOVA statistical analysis are shown in Table 12.

**Table 12. ANCOVA results having 'INTPostSum' as the dependent variable. 'INTPreSum' as the covariate and 'group' as the fixed factor**

Source	Sum of Squares	df	Mean of Squares	F	p
Corrected Model	89.237 <sup>a</sup>	2	44.624	22.256	0.000**
Intercept	59.875	1	59.875	32.265	0.000**
INTPreSum	59.286	1	59.286	26.548	0.000**
Group	44.264	1	44.264	21.268	0.000**
Error	49.127	43	1.985		
Total	2548.000	46			
Corrected Total	149.228	45			

R squared = 0.625 (Adjusted R squared= 0.598); \*\*p < 0.001.

The results showed that the effect of the group was significant at  $p < 0.001$  ( $F = 21.268$ ;  $p = 0.000$ ). In addition, the effect value of INTPreSum, which was considered as covariant, was statistically significant at the level of  $p < 0.001$  ( $F = 26.548$ ;  $p = 0.000$ ). The findings show that the experimental group students who had ethnobotany approach could learn more in Unit: The Systematic of Plants in General Biology course compared to the control group students who followed teacher-based activities. In addition, the final scores of the pre-service teachers from the interview items show a high level of correlation with the first scores. Based on these results, it can be said that pre-service teachers' answers to interview questions aiming to evaluate open-ended questions or subjective thoughts instead of traditional measurement tools contain a more intense meaning and explanation with ethnobotanical practices. The reason is that ethnobotanical practices integrate students with the community so that they can collect and evaluate data from the external environment and construct their own meaningful information instead of encouraging them to use in-class sources that are completely focused on objective reality.

### 3.2.2. Paired t-tests

In addition to the ANCOVA analysis, a paired t-test was performed to compare the first and last scores of the control and experimental groups separately. The first scores obtained from the same interview questions in each group were matched with the last interview scores. In addition, the first and last scores of the pre-service teachers in a group were matched with the scores of the students in the other group. The results of the paired t-test are shown in Table 13.

**Table 13. Paired differences in pre-service teachers' scores on interview items**

Combined pairs	N	$\bar{x}$	SD	SEM	t	p
INTpre Exp–INTpost Exp	24	4.25000	1.80739	0.45185	8.648	0.000**
INTpre Cont–INTpost Cont	22	1.60000	1.18322	0.30551	5.764	0.000**

\*\*p < 0.001.

According to the results of the paired t-test conducted separately in both groups, the scores of the interviews between the experimental group ( $t = 8.648$ ;  $p < 0.001$ ) and the control group ( $t = 5.764$ ;  $p < 0.001$ ) were significantly different.

**Table 14. Pre and post mean scores of pre-service teachers from both the control and the experimental groups on interview items**

Groups	Pre-test scores (Mean)	Post-test scores (Mean)
Control	5.47	8.11
Experimental	5.26	11.24

In other words, pre-service teachers in both groups achieved higher scores in the last interview (Table 14). While the average of pre-interview scores was 5.26 in the experimental group, this value was 11.24 in the last interview. On the other hand, in the control group, the mean score of the first scores was 5.47, whereas the final score was 8.11. In addition, in the first interview, the students of the control group had higher scores than the experimental group, while in the last interview, the control group students were behind the experimental group with a difference of 3.13. In the last interview, the result obtained from the comparison between the groups was found to be significant. In other words, the experimental group seems to have achieved more meaningful learning considering the first and last scores from the interview questions.

In addition, the effect-size correlations were calculated for the first and second pairs. The effect-size correlation,  $r$ , value for the INTpre Exp–INTpost Exp pair (0.7124) indicates a high effect size; and that of the INTpre Cont–INTpost Cont pair (0.4136) indicates a medium to high effect size. In other words, ethnobotanical activities were more effective in the experimental group considering the interview items.

When the quantitative and qualitative data of this study are examined from a holistic point of view, ethnobotanical-based activities seem more effective for learning of the content by pre-service teachers. In particular, the experimental group based on ethnobotany understanding proved more successful in the interview questions. On the other hand,  $t$ -test results indicate significant improvement in scores of both groups in all exam forms. In other words, there is also learning success in the control group. Since academicians do not generally deal with many aspects of learning and they have only a limited level of knowledge, this study can be considered significant as it tried an effective method of teaching by moving learning beyond the classroom. In this changing process, the student is given the right to say more and he is given the opportunity to comment freely by taking his opinions on the subject. In the control group, there was no teacher-centred education. Rather, the teaching was characterised by group discussion, question–answer and interrogative teaching, where idealism was the dominant idea. When the groups were compared against multiple-choice scores, the control group had a higher average score than the experimental group, but the difference between these scores was not statistically significant. No significant difference was found between the groups in open-ended scores. However, the experimental group had a higher score than the control group. Considering the interview; the mean score of the experimental group was significantly higher than the control group ( $F = 21.268$ ;  $p < 0.001$ ) compared to the control group (see Table 12). In this regard, ethnobotanical practices helped pre-service teachers learn considerably in the open-ended and interview materials in relation with analytical and practical learning based on Sternberg's (1985) triarchic assessment approach. This level of development is very important today for the 21st century skills because societies need to have higher thinking skills and meaningful learning to survive.

#### 4. Conclusions and recommendations

This study was carried out with pre-service teachers who were studying in the Faculty of Education. Today, there are serious problems on students' learning about the subject of plants because biology topics were taught with traditional teaching activities so far. Although our country has adopted the concept of constructivist learning, the effect of realism, which has been practiced for about 60 years (1948–2004), has not survived. In realism, the teacher is in the centre and the student is a passive recipient of knowledge. In such an understanding of learning, students should not be expected to

learn significantly because there is a uniform transmission of information within the class. Nowadays, learning has become a phenomenon that goes beyond the classroom. Ethnobotanical practice is a learning approach that aims to integrate the students with the society they live in. In this understanding of learning, students need to be guided about ways of accessing information rather than transferring information. Therefore, it is possible to realise effective, permanent and meaningful learning by students.

In this study, the teaching approach that takes the students to the centre in the teaching process is discussed. For this purpose, multiple sources were used to recognise the plants and to identify the environment of the students. In this approach, which is called ethnobotany, students move away from the textbook and turn to their social environment. Students look at everything they can achieve about plants and process them as data. Nowadays, most schools do not have adequate facilities despite the advanced technology development. Accordingly, teaching processes continue with a teacher-centred approach. In order to have critical thinking and other higher thinking skills, which are described as the 21st century skills, the student should be at the centre of teaching. Although schools do not have technological facilities, they need to adopt the teaching processes organised according to these understandings. It is very difficult to equip students with these skills for the countries as they have been taught under the influence of realism for a long time. It is a fact that students have the problem of expressing themselves freely as they adhere to the objective reality. In this study on the systematics of plants, ethnobotanical approach, which advocates student centrism, was used. All learner-centred practices other than teacher-centred education have a more positive effect on students' learning. One of them is ethnobotanical applications.

In this study, there was no significant difference between the last scores of the experimental and control groups in multiple-choice questions. On the other hand, scores obtained from interview questions were found meaningful in favour of the experimental group. In addition, although the scores obtained from the open-ended items in the written test did not show a significant difference, the experimental group had a higher score than the control group. These results revealed that the ethnobotanical approaches were oriented towards concrete thinking and suggesting realistic solutions. In other words, as Sternberg explains in the theory of triarchic intelligence, the pre-service teachers in the ethnobotany group are more successful in establishing the connections between analytical and applied components, but also open-ended and structured interview questions. These links provide skills that help pre-service teachers to develop more detailed insights and explanations more intensively than standard multiple-choice tests. This is particularly important for university education and pre-service teachers because, at this stage, individuals often collaborate intensively with each other. It is expected that pre-service teachers will be able to perceive, recognise and identify the problem posed to them, develop plans, develop analytical skills related to design and construction, develop feasible solutions and develop products. According to Katehi, Pearson and Feder (2009: 37), curricula, which are considered to be the most important elements of the educational process, also provide students with a variety of skills and thinking processes—analytical and synthetic thinking; detailed understanding and holistic understanding; planning and building; and they want to integrate objective, operational information and distinct, declarative information. However, it should be kept in mind that curricula should be organised according to the appropriate philosophical insights. In fact, it is not possible to expect that the learning will be realised in a concrete and meaningful way when the practices are carried out according to the traditionalist approaches within the teacher training programmes.

In this context, this study also guides pre-service teachers about how to teach biology lesson and how to help students learn better about content and how to build content concepts more accurately. Pre-service teachers learn not only objective reality or content but also how to construct scientific research steps and how they can play a more active role in a research (Lehrer & Romberg, 1996, 69).

Therefore, it should be investigated what kind of understanding of teaching of biology course in teacher training programmes of countries. There should also be studies to address the use of

ethnobotany, which many educators have implemented and considered to be a suitable context for teaching different biology subjects. This study shows that the pre-service teachers taking biology course in line with ethnobotanical practices are suitable for understanding the scientific concepts in seedy and seedless plants and for learning the sufficient content. Therefore, this study, which sets out the suggestions that the biology education in the university should be experienced outside the classroom as opposed to being imprisoned in the classes, also supports the development of various programme materials in this direction in pre-service and in-service teacher training.

Consequently, this study provides at least a suitable context for research disciplines. To date, there have been several studies in biology teaching that demonstrate the effectiveness of learning through different methods other than teacher-centred education; however, very few of these studies have been used in comparison groups (Adhi, Sudarmin & Linuwih, 2018; Bennett, 2005; Brooks, Dolan & Tax 2011; Dangol & Maharjan, 2011; Donleavy-Johnston, 1995; Harrell & Forney, 2001; Haque et al., 2005; Morgan, Hamilton, Bentley & Myrie, 2009; Santos, Guimaraes & Takeo Sano, 2012; Tufenkci, 2006). In these studies, explanations have been suggested mostly by traditional measurement tools. On the other hand, evaluating the end of the process with the tools that give importance to objective knowledge such as closed-ended and multiple-choice tests can offer incorrect results. Therefore, in this study, open-ended items are included in the written form in addition to the multiple-choice test. Furthermore, it can be seen that pre-service teachers participating in learner-centred activities can develop more intense insights compared to other groups in the light of the interview questions with open-ended items.

As a result of the study, the differences between the experimental and control groups indicate a significant level of maturity in the conceptualisation of scientific knowledge. Pre-service teachers who participated in the interview suggested that biology should be more applied to stimulate interest. For this reason, pre-service teachers stated that similar practices could be applied in ethnobotany understanding of other topics of biology. The conceptualisation of the disciplines and the construction of the practices around these concepts to increase the tendency of pre-service teachers towards botanical subjects is an explanation that supports this view. For this reason, the concept or theme-oriented, learner-centred insights should take place at all levels. On the other hand, there is a value given to the scientific reality and the importance of this reality in education processes. Will these pre-service teachers feel the same when they graduate or start teaching? Is this a problem that should be considered for future research?

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## A. Appendices

### A.1. Pre- and post- written test on plants

Name: \_\_\_\_\_ Date: \_\_\_\_\_

## PLANTS—QUESTIONS

1. Which seedless or seedy plants is easier to classify? Circle one.



Explain why.

2. The seeds of seedy plants are open or closed to protect. Gymnosperms is easier to classify than angiosperms.

Why?

- A. There are too many species of Angiosperms.
- B. Angiosperms has a spacious living area.
- C. Angiosperms have complex structural features.
- D. Angiosperms are called by different names among the people.

3. Think about all the plants in your house.

Write name a seedy plant that living in your house \_\_\_\_\_

Write name a seedless plant that living in your house \_\_\_\_\_

4. Give one example of a seedy and seedless plant that is used to treating diseases among the people.

Sample: \_\_\_\_\_

Describe how to use it: \_\_\_\_\_

5. Circle ALL of the plants with transmission bundles on a regular basis.



*Brassica oleracea L. convar. acephala*



*Camellia sinensis*



*Prunus laurocerasus*



*Zea mays*

6. What is the plant in the picture?

- A. Seedless plant
- B. Dicotyledon
- C. Gymnosperm
- D. Monocotyledon



*Actinidia chinensis* Planch.

7. Think about all the plants in your environment.

Write name a seedy and a seedless plant that living in your environment \_\_\_\_\_

8. Think about all the plants at your university.

Write name a seedy and a seedless plant that living at your university \_\_\_\_\_

9. The pictured plant is used .....among the people.

A. as a vegetable dish

B. as stomach pain

medication.

C. to feed animals

D. in order to play

the game

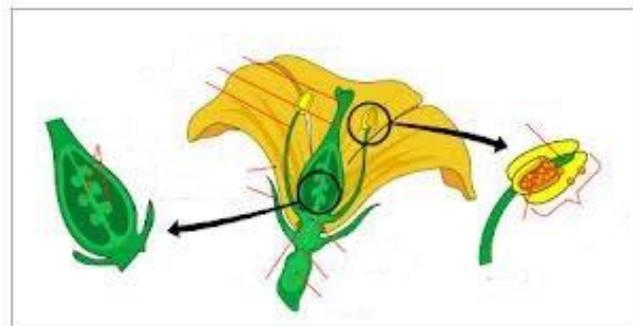


*Brassica oleracea L. convar. acephala*

10. Think of all plants are used in everyday life. First, DRAW sections of the seedy and seedless plants that are used.

Second, LABEL sections of the seedy and seedless plant in your drawing.

11. LABEL and INDICATE the name of ALL the section you see on the picture of the flower below.



### **A.2. Interview protocol**

1. Have you heard of the term ethnobotanic? What do you think of when you hear the words ethnobotanic?

a. Which of the following plants are ethnobotanic plants that used among the people?



*Brassica oleracea L. convar. acephala*



*Camellia sinensis*



*Prunus laurocerasus*



*Zea mays*

b. Why did you pick those plants or parts of the plants for ethnobotanic purpose?

c. What is the purpose of using ethnobotanic plants?

**2.** Can you describe to me the difference between seedy and seedless properties?

a. What is the difference?

b. Can you give me an example of a seedy and a seedless plant?

**3.** The plants kingdom are a group of ecological diversity in the living world. Their sub-categories consisted of seedy and seedless plants. Which plant groups are easier for classification?

Depending on their answer a follow-up question:

a. What do you think about seedy plants?

b. What do you think about seedless plants?

4. See two plant species on the picture. Which plant is used for ethnobotanic purpose among the people. Why that plant?



*Brassica oleracea L. convar. acephala*



*Camellia sinensis*

5. Give samples for Gymnosperm, monocotyledon and dicotyledon plants.

- a. What are the structural and formal differences between Gymnosperm and Angiosperm? Explain.
- b. What are the differences between monocotyledon and dicotyledon plants? Explain.