EFFECT OF PROBLEM-BASED LEARNING METHOD ON COLLEGE STUDENTS' ACADEMIC ACHIEVEMENTS IN GARDEN DENDROLOGY

[1]Yanru Zhang

[1]*College of Innovative Management of Valaya alongkorn Rajabhat university under the Royal Patronage,13180, Thailand.* *yruzhang@163.com*

Abstract

Industrially valued trees and related taxonomic relationships are the primary focus of industrial forestry's Garden Dendrology division. Many woody plants, including native and non-native, are studied in dendrology, a discipline of botany. PBL (problem-based learning) is a methodology in which students learn about a topic by solving an unstructured issue. The intention of this research was to inspect the efficacy of PBL environment on college student's academic achievements in garden dendrology. The students are selected using cluster random sampling method. The students are split into control group and study group. The control group students were provided with traditional learning (TL) whereas the study group student's undergone problem-based learning (PBL) method. The intellectual accomplishments of the students were analyzed using the Analysis of Variance (ANOVA) and Pearson Correlation Coefficient (PCC) methods. The study group was found to be more efficient in terms of critical thinking skills, level of proficiency, and performance level.

Keywords: Garden Dendrology, Problem-based learning (PBL), Analysis of Variance (ANOVA), Pearson Correlation Coefficient, critical thinking skills, academic achievements.

1. INTRODUCTION

Garden Dendrology is a discipline of botany, which focuses on the identification and taxonomy of woody plants, including trees, shrubs, and vines. The important tree & shrub groups are covered within Dendrology as well as Intro to Tree & Shrub. Typical plants and shrubs are studied in the lab. Forestry, ecology, including natural history students need to know how to identify woody plants and trees in the field. The course aims to teach students how to identify woody plants and their taxonomic features. Native, ornamental, especially invasive wood species of plants are introduced in wooded, urban, residential, and riverside environments. The teaching and learning approach seemed to be important for academic achievement in dendrology education. Teaching students nowadays differs from decades ago. Teachers' beliefs about reformed learning and teaching are statistically high, and dendrology education aim is based on constructivist views on learning and teaching.

Traditional lecture-based plant-related programs at differing stages are available at all main forestry and agricultural colleges and institutions, as well as those comprehensive universities that specialize in green architecture. In the traditional teaching, the teachers pay more attention to the setting of the theoretical content and the classroom effect, while ignoring the teaching content such as the practical course and the practice class. As a result, most students majoring in landscape architecture and dendrology are good at theoretical knowledge, but poor at practical ability and innovation ability.

It is crucial to create diverse learning techniques and contexts that foster computational thinking.

In order to achieve a thorough and systematic comprehension of the issues, students must be able to compare, analyze and interpret. People are becoming increasingly aware of how their active participation in the learning experience impacts their learning goals and their individual and career achievement, as companies and educational institutions growingly adopt teaching and training methods that underscore active immersion and participation (Leal-Rodriguez and Albort-Morant 2019). A lack of enrolment, course consolidation, gender inequalities, and bad impression of dendrology courses are issues facing dendrology programmes. In addition, several countries still use the classic lecture technique (Rodrguez-Pieros et al. 2020). Complementing traditional training and expertise, firms now need innovative learning methodologies which are more explicitly focused. The different indicators used for analyzing the student's academic performance are depicted in figure 1.
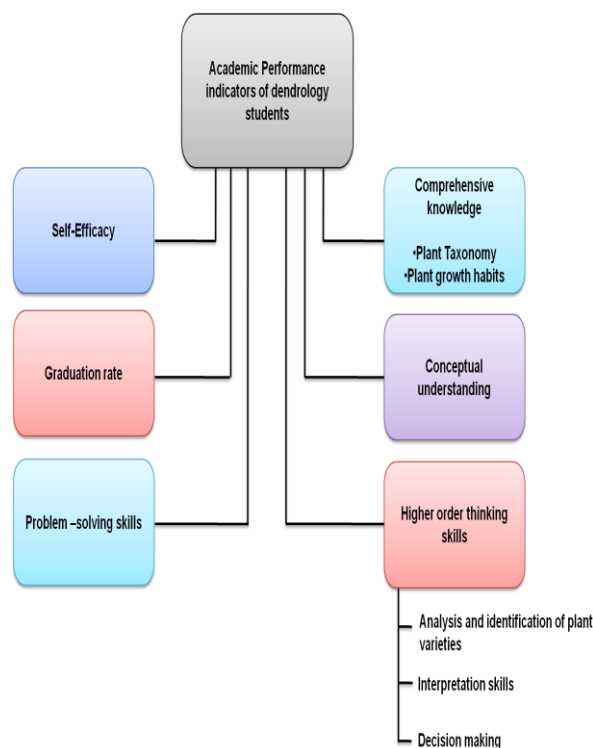

Figure 1: *Student academic performance indicators*

In our study, we studied the effect of PBL on college students' academic achievements in garden dendrology. The rest of this part is devoted to Section II, which explains the literature work and problem statement, Section III, which illustrates the approach utilized, and Section IV, which examines and assesses the methodology's performance. Finally, in section V, the paper's conclusion is presented.

II. LITERATURE SURVEY

Al-Rahmi et al. 2018 explored the intentions of university students to use e-learning. A technological acceptance model is the foundation of this study, and we put it into practise throughout the article. Structural Equation Modeling (SEM) and SmartPLS software are used to study students' adoption process. Results show that e-learning material and students' self-efficacy have an influence on students' perceptions of e-value, learning's as well as their willingness to use it. Oweis 2018 investigated the effect of blended learning on the achievement and motivation to learn English of German Jordanian University students. Academic self-efficacy (ASE) and problem-solving skills (PSS) will be examined by KaraoglanYilmaz 2022 in relation to suggestions and advice learning - based analytics in this project. Experimental design with a pre- and posttest control group was utilised in the study, and a mixed - method approach (QUAN + qual) was employed. 44 university students were randomly allocated to the experimental (LA) or control groups in this study (non-LA groups).

D'Alessio, Avolio and Charles 2019 showed how critical thinking of students pursuing a Master's degree in Business Administration (MBA) using assignment affects their grades. Analysis of variance (MANOVA) is used to examine the influence of critical thinking on the academic performance of a sample of 1620 executive MBA students, in each of four academic domains (i.e., Operations, Marketing, Finance, and Strategy & Leadership. The purpose of Sahinand Yilmaz 2020's study is to find out how augmented reality (AR)-based learning materials affect middle school students' academic performance and attitudes about the course, as well as their views regarding AR applications in general. Aslanand Duruhan2021 studied the impact of virtual learning environments built to meet the PBL strategy for 7th-grade science classes on students' performance. Students' academic performance, problem-solving abilities, and intrinsic motivation were studied and evaluated in great detail in light of these unique learning settings.

Mixture of qualitative and quantitative approaches was used in this situation.

Moradian, Alipour and ShehniYailagh 2021 used academic self-efficacy and success motivation as a mediator to explore a causal association between parenting styles & student accomplishment. There was also a direct link between academic self-efficacy and academic success, however there was no significant link among achievement motivations and academic performance. In scientific education, Beier et al. 2019 investigated the impact of project-based learning (PjBL) courses on student attitudes and career goals. Chang and Hwang (2018) used AR-based learning material to provide multiple perspectives on the plants they were studying.

Problem Statement

Both educators and students consider learning garden dendrology to be a difficult task. Face-to-face learning is unlikely to be sufficient in promoting successful teaching and learning solutions on its own. As a result, having an appropriate teaching and learning approach can be beneficial in a variety of scenarios and enables learners to participate actively and effectively in dendrology lessons.

III. METHODS AND MATERIALS

The primary goal of this study was to determine the impact of PBL on college students' academic achievements in garden dendrology. The students are chosen using the cluster random sampling method. The students are split into control group and study group. The control group students were provided with TL whereas the study group students undergone PBL method for one month. The questionnaire was distributed to every participant to collect their views about the learning method provided to them at the end of the course. The academic achievements of the students were quantitatively analyzed using ANOVA and PCC methods. The flow of this study work is provided in figure 2.
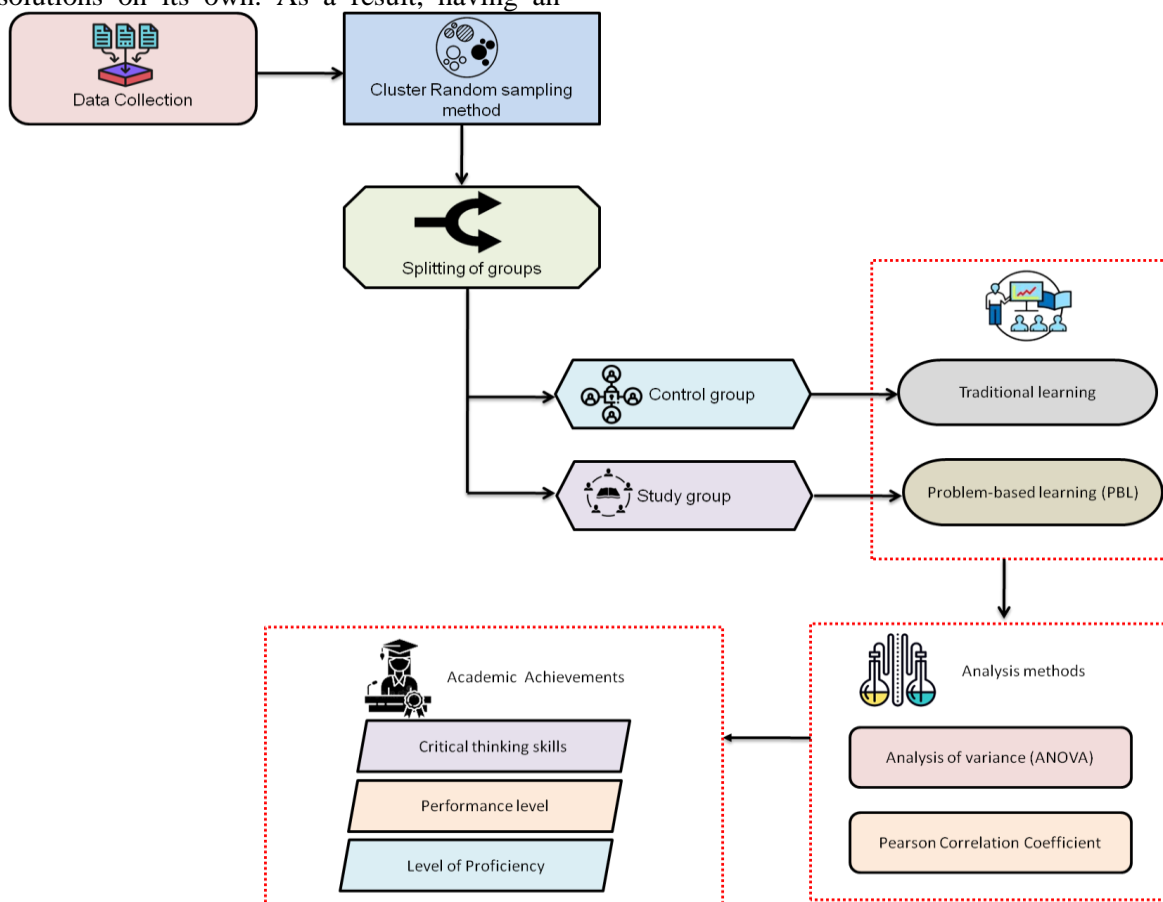

Figure 2: *Flow of the research work*

a) Student Selection

This study selects 100 undergraduate students belonging to Forestry and Management of the Environment and Natural Resources department at Democritus University of Thrace's Agricultural and Forestry Sciences, Orestiada, Northern Greece (Karasmanaki, E. and Tsantopoulos, G., 2021). One of the main subjects in forestry education is dendrology that covers the taxonomic and silvical characteristics (life history, growth, behavior and ecology of a tree species), genetic relationships, ranges, and uses of forest trees. Cluster random sampling is used to pick students for the study. Cluster random sampling is a probability sampling approach in which the population is divided into clusters or smaller groups first, and then students are picked at random from the cluster samples to conduct research and gather data. The participants were chosen depending on their willingness to involve in this research. The participants were split into control and study groups. Each group consists of 50 students.

b) Traditional Learning (TL)

TL method is used to teach garden dendrology to students in the control group. TL is a face-to-face, lecture-based teaching method that uses a variety of representative plant material to convey technical botanical vocabulary and plant morphology. For students to develop plant identification abilities, face-to-face guided, hands-on training to quickly dissect and examine parts and structures of plants is important. Students were given the chance to dissect and study a specimen by hand. The information transfer is only from teachers and students are not involved in information transfer and interactions.

c) Problem Based Learning

The garden dendrology education is provided to students of study group using PBL approach PBL requires students to engage in a lot of self-directed learning behavior. Students have to take the initiative themselves to find explanations and solve problems. Teachers facilitate and guide students in acquiring subject-matter knowledge and skills as well as helping them to become life-long self-directed learners.

In PBL, students are divided into small tutorial groups of six to ten peers. Even before they are presented with any course content in the form of

textbooks, they are confronted with the problem related to plant identification as the starting point of the learning process during their first meeting. It's usually the problem that comes first. They will be expected to discuss the issue with the help of a tutor. The group will first generate a preliminary analysis of the problem depending on their existing knowledge, similar to the study performed in the opening paragraph of this book. This rudimentary study will raise questions regarding aspects that were not previously understood, clarified, or explained. Students will utilize these questions as learning objectives for self-study. Students will work toward these learning goals, either alone or in groups, during the time between tutorials – generally a few days – by reading articles and books, watching video cassettes, visiting instructional staff, and so on. Following the phase of self-study, the students report back to each other in the session, sharing what they've learned and assessing how far their self-study has helped them comprehend the topic better. Figure 3 shows the steps involved in PBL.
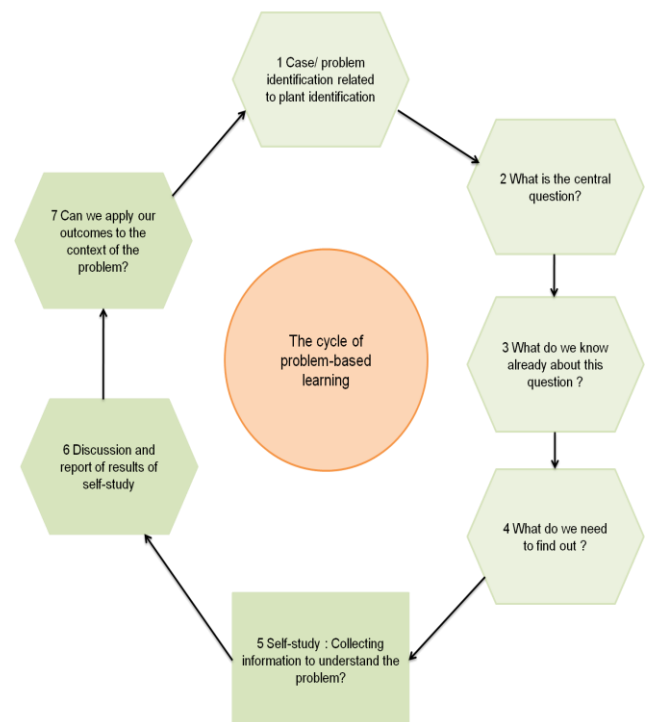

Figure 3: *Steps in PBL*

d) Statistical Analysis

Statistical analysis is performed to study the impact of PBL on academic achievements of students majoring in dendrology using ANOVA and PCC strategies. The dependent variables used in this study to assess the impacts are

learning outcome, self-efficacy, learning motivation, critical thinking skills, and so on. ANOVA is a statistical test that determines if mean of two or more groups are equal, and so extends the F-statistics to include more than two means. An estimate of linear association between two sets of data is the Pearson correlation coefficient, often known as Pearson's r. It's the ratio of two variables' covariance to the product of their standard deviations. It is effectively a normalized measurement of covariance, with the result always falling between 1 and -1. The estimate can only reflect a linear association of variables, similar to covariance, and ignores several other types of correlation.

IV. RESULTS AND DISCUSSION

This section provided insights into the effectiveness of PBL in improving academic achievements of college students compared to TL. The questionnaire filled by the students is quantitatively analyzed by various statistical tools. Table 1 shows the results of ANOVA. The findings of ANOVA revealed that the study group performed better in terms of Conceptual Knowledge on tree taxonomy, Plant identification skills, Plant specimen interpretation skills, Critical Thinking Skills, Problem-Solving Skills, Decision making skills, Learning satisfaction, Self-efficacy, Learning motivation, Communication skills, and Overall academic achievement than the control group as the mean score of the experimental group in each term was higher than that of the control group. There was a major disparity involving the 2 groups; that is, the participants who educated with the PBL technique indicated the considerably enhanced learning than those who educated with the TL since p-value is less than 0.05. Basic tasks such as reading and remembering in TL schools need students to employ just the minimum aspects of cognitive functioning. As a result, pupils may only have a cursory understanding of the material; they will be unable to apply the knowledge and skills and will be discouraged from self-studying. But in PBL, students are induced to study on their own which helps in better understanding of the dendrology concepts. The increased motivation is because PBL makes learning interesting and thrilling.

Table 1: *Results of ANOVA test*

Dependent variable	TL (Control group)		PBL (Study group)		F-statistic	p-value	Effect size (Cohen's d)
	Mean	Standard deviation	Mean	Standard deviation			
Conceptual Knowledge on tree taxonomy	4.6	0.53	3.21	0.67	12.43	0.04	0.68
Plant identification skills	4.45	0.86	2.54	0.66	7.54	0.04	0.74
Plant specimen interpretation skills	4.65	0.73	3.23	0.65	6.43	0.035	0.76
Critical Thinking Skills	4.32	0.67	1.36	0.87	8.54	0.046	0.83
Problem-Solving	4.2	0.76	2.3	0.76	9.43	0.023	0.89

Skills							
Decision making skills	4.72	0.56	1.65	0.54	5.76	0.032	0.74
Learning satisfaction	4.7	0.34	1.43	2.76	9.43	0.032	0.78
Self-efficacy	4.52	0.87	2.36	0.76	4.76	0.025	0.76
Learning motivation	4.46	0.54	2.12	0.65	8.54	0.033	0.832
Communication skills	4.3	0.75	1.9	0.55	9.43	0.021	0.754
Overall academic achievement	4.7	0.65	1.13	0.76	8.43	0.015	0.8

In order to determine the quality and orientation of the linear link between two factors, Pearson's correlation coefficient has been used to calculate the Correlation coefficient. Table 2 shows the relationship between learning approach and student learning outcomes. The Pearson coefficient for the relation between PBL and different learning outcomes is higher than 0.5 which indicate that the PBL significantly enhances the dendrology student's academic achievements. Significant correlation emerged between PBL and learning outcomes was very much higher than that between TL and learning outcomes.

Table 2: *Results of PCC test*

Dependent variable		Learning method	
		PBL	TL
Academic achievement	Pearson-r	0.85	0.13
Self-efficacy	Pearson-r	0.76	0.18
Higher order thinking abilities	Pearson-r	0.86	0.23
Conceptual knowledge	Pearson-r	0.76	0.54
Plant identification skills	Pearson-r	0.87	0.43
Plant specimen interpretation skills	Pearson-r	0.769	0.32

Figure 4 shows the effect size (ES) of significance of different learning approaches. The mean weighted effect size of significance of PBL in improving student's learning achievements was 0.8. The ES of PBL was greater than that of TL, project based learning (PjBL), and augmented reality (AR) based learning. Participants in PBL outperformed those in TL when it came to grade point average, suggesting that PBL can have an intermediate to major positive impact on student grades.
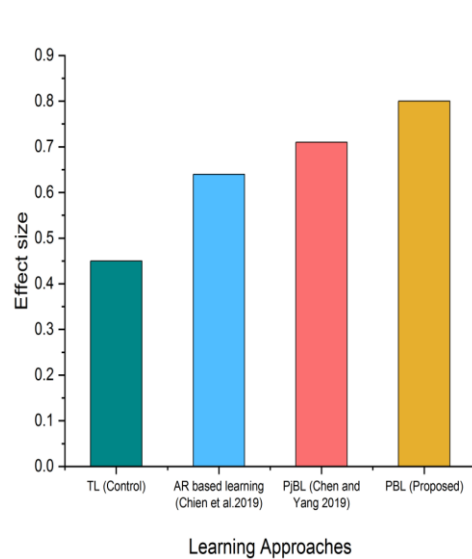
Figure 4: *Significance of different learning approaches in terms of academic achievements*

Figure 5 depicts the mean score of self-efficacy, learning motivation, and critical thinking tendency in experimental and control groups. As a result of the PBL technique, the students' self-efficacy, learning motivation, and thinking abilities are greatly enhanced while compared to TL. Figure 6 illustrates that the pass percentage of dendrology students pursuing PBL was higher than that of students pursuing TL. 92% of study group passed the examination conducted at the end of the course. But, only 65% of control group passed the examination. This proved that PBL enhanced the academic achievements compared to TL in garden dendrology.
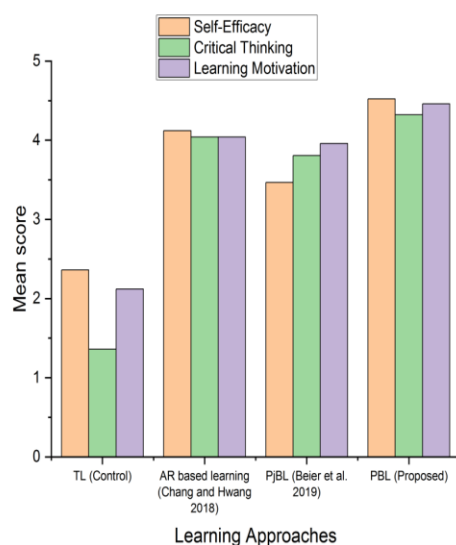

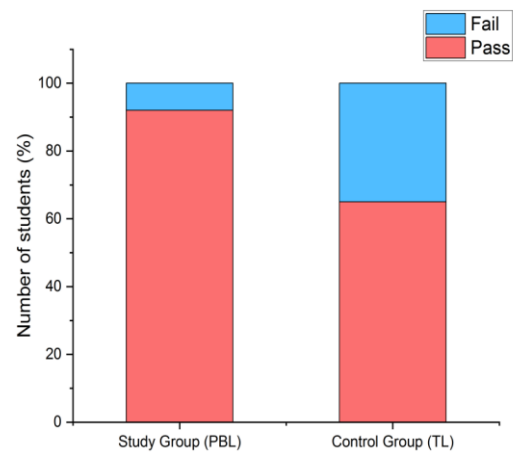Figure 5: *Comparative analysis of different methods based on various skills*

Figure 6: *Pass percentage of students*

V. CONCLUSION

PBL is a form of coaching where learners (students) learn by solving problems. This study's goal was to see how PBL affected college students' garden dendrology grades. TL was given to the control group, whereas PBL was used for the study group. The students' academic achievements were analyzed using ANOVA and PCC. The study group outperformed the control group in. It was found that, with the assist of the PBL, the learners' learning accomplishments, learning inspiration, critical thinking affinity, and group self-efficacy were appreciably enhanced compared to TL. Significant correlation emerged between PBL and learning outcomes was very much higher than that between TL and learning outcomes.

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