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Preferred Laboratory Learning Strategies in Biology and Related Subjects

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Abstract *- The research was conducted to determine the preference of tertiary students enrolled in science programs in terms of their experienced laboratory learning strategies in the biology laboratory. A total of 107 student respondents from three different science programs available in Pangasinan State University – Lingayen Campus were surveyed with a structured questionnaire to determine their levels of preferences among their experienced laboratory learning strategies. The results were then analyzed using Chi-square test of association and linear regression to determine significant relationships with their demographic profiles. There were seven laboratory learning strategies that were previously encountered by the respondents. Most of the respondents' answered that they highly preferred those previously encountered learning strategies. Results of the chi-square tests also showed significant differences in the levels of preferences of the respondents in the different learning strategies. Regression analyses showed significant relationships between the age of the respondents and their high preference in three learning strategies, i.e., inquiry-based, research-based (exploratory) and computer assisted strategy. Significant relationship was also found out between the sex of the respondents and their high preference in all the learning strategies. There was also a significant relationship between the number of subjects previously enrolled by the respondents and their high preference in the teacher demonstration strategy.*

Keywords*: laboratory strategies, exploratory, inquiry-based, computer assisted strategy*

INTRODUCTION

The major goal of science education is to foster the students' intellectual competencies such as independent learning, problem-solving, decision-making and critical thinking [1]. Biology as a science subject is a practical-oriented subject that focuses more on knowledge application than mere knowledge acquisition [2].

Biology plays a vital role in the economic development of a nation, specifically in most human activities including finding solutions to the problems of food security, pollution, population explosion, climate change, disease outbreak, family health, poverty eradication, management and conservation of natural resources, various social vices as well as biotechnology fields and ethics [1]. Given its important role in the economic development of a nation, biology is a subject that must be properly taught and learned by tertiary students in order to make it functional and relevant. Osuafur and Amaefuna also stated that effective biological science teaching should be laboratory oriented rather than text and lecture-oriented [3]. Therefore, functional biology education should develop in the students the right attitude, interest, and skills to cope with the life around them.

According to Cimer, there are many reasons why students have difficulties in learning biological concepts [4]. The nature of biology itself and its teaching methods and learning strategies are among the reasons for the difficulties in learning this subject. The abstract and interdisciplinary nature of biological concepts and difficulties with textbooks are other factors preventing a student from learning biology effectively [5]. These, of course, prevent meaningful learning. Designing learning strategies while ignoring students' interests and expectations cause several learning problems as

well as decreasing their interest in biology [6][7]. Fraser [8] indicated that there is a close relationship between students' perception of their learning strategies and their success. If students are not happy with the way that biology is learned, they may show disinterest in and negative attitudes towards biology and its learning. It is, therefore, crucial to understand students' views on what makes their biology learning effective, as many researchers suggest that in order to improve the quality of learning, students' views must be taken into consideration by researchers, teachers, and schools [9][10][11]. It is thought that how students perceive their learning strategy in biology affects their attitudes towards biology and its learning [4]. Therefore, understanding higher education students' preference in learning strategies in biology will help policymakers, teachers and teacher educators plan more effective learning activities that can help students learn biology better.

This research was conducted to determine the preference of tertiary students enrolled in science programs in terms of their experienced laboratory learning strategies in the biology laboratory. Specifically, this study was conducted to identify which of the current learning strategies employed by their instructors in biology and related subjects' best fits their preference and produce a sample instructional material based on the results of the survey. This information will then be the baseline for developing instructional materials that can be used to improve future laboratory classes.

METHODOLOGY

Research Design

This research used descriptive method design which focused on surveying the preference of science course students. The results of the survey were then tallied and analyzed to produce information as to which is the best-preferred learning strategy of the respondents based on their experience in their laboratory classes.

Development of Survey Instrument

The survey instrument developed sought information based on the respondents' profile, such as their age, gender, and the current program they are enrolled in. Their previously and currently enrolled biology-related subjects were then identified together with the preferred learning strategies they have already encountered. The last question in the survey was supplemented with a Likert scale that provided different levels of preference as to the given learning strategies. The developed instrument was validated in terms of presentation and content.

Survey of Students

A total of 107 respondents from three different science programs in Pangasinan State University-Linagyen Campus, i.e, BS Biology, BS Secondary Education major in Physical Science, and BS Nutrition and Dietetics, was then randomly selected for the survey. The purpose of the survey was explained to the students before they answered the questionnaire. The students were freshmen to seniors, i.e., 50 freshmen and 57 seniors. All of the respondents have either previously or are currently enrolled in biology-related subjects.

Statistical Analysis

The answers of the respondents were tallied using MS Excel and statistically analyzed using IBM SPSS version 25. Descriptive statistics were determined such as Mean, Mean Average, Mean Differences and Standard Deviation. Comparison of Means was then employed using Chi-square Test of Association and Linear Regression to determine significant relationships between their preferred learning strategies and their demographic profiles.

RESULTS AND DISCUSSION

Respondents' Demographic Profile

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A total of 107 respondents from three science programs in PSU Lingayen Campus were surveyed using a validated structured questionnaire to determine the levels of preference of the students in the different laboratory teaching strategies that they have encountered. Table 1 summarizes the number of respondents gathered. Table 2 summarizes the profile of the respondents' age. Table 3 summarizes the profile of the respondents' gender. A total of 15 Biology-related subjects have been enrolled by the respondents. Table 4 summarizes the number of respondents who have enrolled in each subject. Table 5 summarizes the number of semesters that the respondents have taken up in enrolling in the different Biology-related subjects.

Table 1. No. of respondents per science program

Science Program	No. of students	Frequency (%)
BS Biology	52	48.6
BS Ed. Major in Physical Science	35	32.7
BS Nutrition and Dietetics	20	18.7
Total	107	100

Table 2. Age of respondents

Age	No. of students	Frequency (%)
18	9	8.4
19	22	20.6
20	48	44.9
21	20	18.7
22 above	8	7.48
Total	107	100

Table 3. Gender of respondents

Gender	No. of students	Frequency (%)
Male	30	28.0
Female	77	72.0
Total	107	100

Table 4. Biology-related subjects enrolled by the respondents

Subject	No. of students	Frequency (%)
General Biology	100	93.4
General Botany	38	35.5
General Zoology	15	14.0
Anatomy and Physiology	67	62.6
Microbiology and Parasitology	65	60.8
Cellular and Molecular Biology	80	74.8
Biotechnology	69	64.5
Histology and Microtechnique	61	57.0
Genetics	22	20.1
Entomology	70	65.4
Mycology	69	64.5
Plant and Animal Morphoanatomy	69	64.5
Plant and Animal Physiology	69	64.5
Principles of Food Safety, hygiene, and sanitation	20	18.7
Systematics	79	73.8
Total		

Table 5. No. of semesters enrolled by the respondents in taking up Biology-related subjects

No. of semesters	No. of students	Frequency (%)
One	6	5.6
Two	31	29.0
Three	6	5.6
Four	2	1.9
Five	0	0
More than five	67	62.6
Total		100

Respondents' Level of Preference in Laboratory Learning Strategies

There were seven laboratory teaching strategies that were experienced by the respondents while enrolled in different Biology-related subjects. These include inquiry-based, teacher demonstration, research-based (exploratory), practical work, computer-assisted teaching, journal analysis and teamwork-based problem-solving. Table 6 summarizes the number of respondents who have experienced given laboratory teaching strategies. Among the different laboratory learning strategies, the respondents' preferences were summarized in Tables 7-13.

Table 6. No. of respondents who have experienced different laboratory learning strategies

Laboratory teaching strategies	No. of students	Frequency (%)
Inquiry-based	94	87.9
Teacher demonstration	96	89.7
Practical work	95	88.8
Research-based (exploratory)	94	87.6
Computer-assisted	97	90.7
Journal analysis	87	81.3
Teamwork-based problem solving	95	88.8

Table 7. Levels of preferences of respondents in the different laboratory learning strategies

	Highly preferred			Preferred			Slightly Preferred			Least Preferred		
Learning strategy	No.	%	Rank	No.	%	Rank	No.	%	Rank	No	%	Rank
Inquiry-based	91	85.1	2	13	12.5	6	2	1.9	2.5	2	1.9	1
Teaching demonstration	99	92.5	1	9	8.41	7	0	0	6	0	0	3.5
Practical work	88	82.2	3.5	18	16.8	4.5	2	1.9	2.5	0	0	3.5
Research-based (exploratory)	88	82.2	3.5	18	16.8	4.5	0	0	6	0	0	3.5
Computer-assisted	83	77.6	6	24	22.4	1	1	0.9	4	0	0	3.5
Journal analysis	73	68.2	7	22	20.6	2	9	8.4	1	1	0.9	2
Teamwork-based problem solving	86	80.4	5	20	18.7	3	0	0	6	0	0	3.5

Table 7 summarizes the levels of preferences of the respondents in the different laboratory learning strategies they have encountered or experienced. Among the "highly preferred" learning strategies, teaching demonstration strategy ranked first (92.5 %). Respondents' survey answers also showed that 22.4% of them "preferred" computer-assisted strategy first among all the learning strategies. among the "slightly preferred" strategies, respondents ranked journal analysis first (8.4%), while among the least preferred learning

strategies, inquiry-based strategy ranked first (1.9%).

The novelty, spectacle, and inherent drama of an in-class demonstration can provoke significant interest from students. Psychologists termed this kind of interest, situational interest, which spontaneously creates interest among all students [12]. The demonstration strategy is effective for long-term memory retention and appropriate to college students' skills [13]. The act of demonstration readily helps to kindle more natural reactions between students and the teacher. Their active responses and completely spontaneous observations provide an excellent opportunity for the teacher to connect with them and with their unedited ideas.

Table 8. Chi-square test results on the level of preference of respondents in the different laboratory learning strategies

Learning strategies	Pearson Chi-Square	Remarks
Inquiry-based	0.000	Significant
Teacher demonstration	0.000	Significant
Practical work	0.000	Significant
Research-based (exploratory)	0.000	Significant
Computer-assisted	0.000	Significant
Journal analysis	0.000	Significant
Teamwork-based problem solving	0.000	Significant

Demonstration strategy has emerged to become an instructional approach that is gaining rising interest within the biology education community [14]. Research has found that diverse students benefit vastly when they have opportunity to participate in activities, interact with materials and manipulate objects and equipment [15] [16]. An earlier work that made use of demonstrations in biology education reported an increase in student attendance from 30% to 80% [15]. Moravec et al [14], in their study of actively engaging students in their biology laboratory classes through demonstrations also resulted in 21% increase in examination performance and other learning gains. It is therefore implied that creating a more learner-centered environment in biology laboratory classes through active in-class demonstrations is highly preferred by the students because it increases their engagement, encourage their critical thinking, and improve their attitude and behavior toward the biological sciences.

Significant differences in the levels of preferences

Using chi-square test to determine significant differences in the respondents' level of preference in the different laboratory teaching strategies, As seen in Table 8, the chi-square results showed significant differences in the levels of preferences in the different laboratory learning strategies encountered by the respondents. The chi-square results further solidify the need to give biology students a feeling or participation, confidence and interest in what they do with their hands so as not to perceive biology as merely theoretical study. For this to be achieved, teaching biology must be practical-oriented [1]. Biology laboratories are places where different types of experiments and researches concerning all the disciplines of life science take place for acquisition of skills. These skills, however, cannot be acquired if there is no effective teaching and learning strategies geared toward empowering the students to become qualitatively and functionally educated.

Significant Relationships between the respondents' levels of preferences and their demographic profiles

Using linear regression analysis, significant relationships were determined between the respondents' highly preferred laboratory learning strategies and the number of Biology-related subjects they have previously enrolled to. In the regression analysis between the

age of the respondents and their highly preferred learning strategies, three strategies stood out to be significantly related to the respondents' age. i.e., inquiry-based research-based, and computer-assisted strategies. In relationship with the sex of the respondents, their highly preferred learning strategies were found out to be significantly related. In terms of the number of the Biology-related subjects previously enrolled, their high preference in teacher demonstration strategy was the only strategy found out to be highly related.

In relationship with age, this study has found out that there is a significant increase in the high preference of students in inquiry-based (R2 = 0.5234), research-based (R2 = 0.8745) and computer-assisted (R2 = 0.8106) learning strategies. The respondents' high preference in the aforementioned learning strategies increases with their age. Students in inquiry-based classes must modify their perception of their role in the classroom from passive follower to active designer [17]. This statement was further explained by Tuan et al [18] by stating that inquiry-based teaching can provide an open learning environment with opportunities for students to explore and construct meaningful knowledge. In addition, research, as a learning modality, is highly valued for its ability to teach students integrative and critical thinking [19]. Research-based learning strategy also benefits students by clarifying their career path, being independent in work and thought and having a sense of accomplishment [20]. In terms of computer-assisted instruction, previous studies have found out that student performances produce higher achievement since they learn instructional content faster and they retain what they have learned better [21] [22].

In terms of gender, the study also found out a significant relationship between the respondents' high preference in the different learning strategies. Male respondents seemed to highly prefer practical work (R2 = 1), research-based (R2 =1), computer-assisted (R2 =1) and teamwork-based problem solving (R2=1) learning strategies more than the females whereas the female respondents to highly prefer inquiry-based (R2=1), teacher demonstration (R2 =1) and journal analysis (R2 =1) learning strategies better than males. A study conducted by Chiou et al [23], indicated that whether gender plays a role in students' approaches to learning remains an unclear issue even though it may imply that gender differences in approaches to learning might depend on the learning discipline and context. Nevertheless, a good learning strategy should be able to neutralize any gender differences.

In terms of the number of Biology-related subjects enrolled, one significant relationship was found out with that of the respondents' high preference in teacher demonstration strategy (R2= 0.9808). As seen in figure 16, those respondents who have previously enrolled in more than six biology-related subjects most highly preferred teacher demonstration learning strategy. Giridharan and Raju [12] stated that in-class demonstrations is a standard constituent of science courses in schools and universities, and are generally believed to help students understand science and stimulate student interest. Most students get a great deal more out of visual information than verbal information. Demonstrations provide a multi-sensory means to describe a concept, idea, or product that may otherwise be difficult to grasp by verbal description alone [12].

CONCLUSION

According to the surveyed respondents, teacher demonstration strategy is their most highly preferred learning strategy and their high preference in the said strategy is significantly related to the number of biology-related subjects they have previously enrolled. It is important to note also that teacher demonstration is the most widely used teaching strategy for acquisition of practical skills as it includes the verbal and practical illustration of a given procedure. Additionally, it is considered a highly effective learning strategy because it contains active participate of the students and can be attributed to increase students' academic achievement because

of the immediate appreciation of concepts from practical examples that the students experienced from the demonstrations.

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