

Correlating biophysics anxiety and performance among biology students in two state Universities in Mindanao, Philippines

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ABSTRACT

This study investigated the influence of biophysics anxiety on the performance of biology students. It utilized a descriptive-correlational quantitative research design. A twenty-five item Biophysics Anxiety Rating Scale was adopted and modified to measure the level of biophysics anxiety among the one hundred twenty-six selected college students in Mindanao. The study found that there are four constructs formed, and all of them have a moderately anxious level of students' anxiety. These constructs are as follows: construct 1 - lack of foundational knowledge, construct 2 - test taking and instructor's presence, construct 3 - lack of laboratory skills, and construct 4 - lack of self-confidence. The majority (43.65%) of the students received a final grade of excellent. Additionally, no significant difference was observed in the level of anxiety between male and female students. Moreover, students' demographic profile, such as the university attended, sex, and SHS strand, has no significant influence on the level of anxiety in biophysics. However, age is significant, implying that students in different age brackets may experience different levels of anxiety. Furthermore, there was no significant influence between the constructs manifested by students and their performance in biophysics. Thus, the level of anxiety among students is not an indicator of the performance of biology students. Further study is suggested to consider other factors that may contribute to the differences in the level of anxiety among biophysics students.

1. Introduction

Many students who are enrolled in higher education institutions encounter numerous challenges. Physics, along with chemistry and mathematics, has been identified as one of the most difficult subjects most college students have encountered during their undergraduate years based according to Bustami et al. (2020). When students try to overcome these challenges, they might change the way they behave. Numerous studies have shown that science and mathematics anxiety have some effects on the learning achievement of students, according to Akman et al. (2007). A lot of students experience anxiety when they feel like they will not be able to reach their academic or personal goals. According to Alkandari (2020) it is important to understand the factors that cause students' anxiety at higher education institutions. One of the main causes of

anxiety is attributed to curriculum difficulty. There are students who find it difficult to grasp the curriculum and face challenges when it comes to participating in class discussions, completing assignments, and writing research papers or reports. Academic anxiety is a well-established, significant predictor of academic performance such that students with high levels of anxiety are unable to perform at the best of their ability (Mirawdali et al., 2018). There are also existing studies revealed that the level of science and mathematics anxiety somehow differs based on students' gender (Chiarelott & Czerniak, 1987; Mallow et al., 2010; Udo et al., 2004). Anxiety is generally defined as apprehension and fear caused by the anticipation of a potentially dangerous event or situation (Nordqvist, 2009). Anxiety is one of the prominent affective variables that may correlate with students' performance.

Biophysics is a branch of physics that explains the importance of biological studies with respect to the principles of physics and chemistry along with mathematical methods. In the Philippines, there are only a few undergraduate programs that offer biophysics as either a major, cognate, or elective. The BS Biology program as prescribed by CHED Memorandum Order No. 49, s. 2017 requires students to enroll in 18 units of biology tool courses that include Chemical Biology, Biostatistics, and Biophysics. Students frequently complain about biophysics anxiety and poor academic performance in biophysics classes, and failure situations are known to elicit anxiety responses. While students are expected to have a good grasp of biological and physical science concepts in high school through a spiral progression of the science curriculum, there are issues with teacher specialization, lack of teaching experience, inadequate training, and unavailability of learning materials and textbooks, among others (Quintos et al., 2022). There have only been a few studies that link these two variables. There are also existing studies that revealed that the level of science and mathematics anxiety somehow differs based on students' gender (Chiarelott & Czerniak, 1987; Mallow et al., 2010; Udo et al., 2004). Moreover, studies investigating the difference in the level of biophysics anxiety in students' gender reported that females have higher physics anxiety levels compared to males (Beilock et al., 2010; Medina et al., 2003).

There are limited studies that center on assessing the anxiety of college students, specifically on the course biophysics, since there are only specific degree programs that occur in this course as part of the program of study. Moreover, there are students enrolled in the biology programs that are not from the Science, Technology, Engineering, and Mathematics (STEM) strand, which may also be a cause of concern considering that biophysics requires a good background in biology, physics, and chemistry. Hence, this descriptive correlational study will investigate the level of anxiety and its relation to performance in biophysics among students in the BS Biology program at two state universities in Mindanao, Philippines.

2. Theoretical basis

This study is anchored on Eysenck and Calvo's (1992) processing efficiency theory which states that anxious individuals engage in more worry (i.e., self-preoccupation, concern over evaluation, concern over performance) than non-anxious individuals, and worry preempts some of the resources of the central executive and the articulatory loop. The study conducted by Bryant et al. (2013) examined Science Anxiety, Science Attitudes, and Constructivism. The findings revealed that females in both the US and Danish cohorts exhibited significantly higher levels of science anxiety compared to males. Additionally, the gender differences observed among the American participants were found to be greater than those observed among the Danish participants. According to this idea, worry decreases the storage and processing capacity of the working memory system for a task and increases effort and actions aimed at enhancing performance. PET elucidates that cognitive activity, like a concern, has two primary effects.

Worry consumes processing and storage resources in working memory and competes with task-relevant ideas for these resources. Furthermore, anxiety can act as a powerful motivator for individuals to avoid the negative outcomes associated with a hazardous circumstance. One strategic solution to such conditions is to commit more processing resources to performance by increasing in effort. Increased effort is intended to sustain performance effectiveness and prevent the negative outcomes of failure. In the context of students' performance, anxiety impedes them to maximize their potential to perform well in academics, this is more so in courses that require analytical and problem-solving skills such as biophysics.

3. Methodology

This study utilized descriptive-correlational quantitative research. Descriptive correlational research describes the relationships among variables rather than inferring cause and effect relationships (Lappe, 2000). This study determined the level of biophysics anxiety and performance in biophysics among biology major students. The correlational design determines if there is a significant relationship between biophysics anxiety and performance in biophysics and whether this correlation differs when students are grouped according to age, sex, SHS strand, and course major. A purposive sampling technique was used in choosing the respondents for this study. The study was conducted on some of the State Universities and Colleges across Region X in Mindanao offering Bachelor of Science in Biology, which have Biophysics as one of the subjects. This study adopted and modified the 5-point Likert on Biophysics Anxiety Rating Scale developed by Sahin et al. (2015), a data collection tool, using Principal Component Analysis (PCA), more correlated items were grouped, forming the modified Biophysics Anxiety Scale. The questionnaire used in this study consists of two parts, namely: (1) the respondents' socio-demographic background (such as age, sex, SHS strand, and course major), and (2) the biophysics anxiety rating scale, the scale initially consisted of the following constructs: 1) Anxiety on lack of foundational knowledge, 2) Anxiety on test-taking and instructor's presence, 3) Anxiety on lack of laboratory skills and 4) Anxiety on lack of self-confidence. The student's grades in their biophysics subject were collected and used as the basis for their performance. The data was tabulated and subjected to the following statistical tools: (1) mean, for determining the level of biophysics anxiety among biology major students in terms of biophysics, (2) Chi Square, for determining the significant difference when respondents are grouped demographic profile, and (3) regression analysis, for determining the significant correlation between students' biophysics anxiety and their performance.

4. Result and discussion

The biophysics anxiety and performance of BS Biology students in two State Universities in Mindanao were investigated. The following section presents the results after analysis of the data.

Table 1 displays the specializations of the participants, who are students pursuing a Bachelor of Science in Biology (BS Bio) degree. According to CMO 49 s. 2017, students have the option to select from the available specializations provided by their respective universities. Out of the 126 participants, 34 (26.98%) are pursuing a major in plant biology, 31 (24.60%) are specializing in microbiology, 28 students (22.22%) are studying molecular biology and biotechnology, 26 students (20.62%) are focusing on animal biology, and 07 students (5.56%) are majoring in biodiversity. The decision regarding which specializations to offer is determined by the college or university, taking into account factors such as faculty expertise, resource availability, and the university's specific niche.

Table 1*Frequency Distribution of Demographic Profile of the Biology Students in terms of Course and Major*

Course and major	Frequency	Percentage
BS Bio (Animal Biology)	26	20.63%
BS Bio (Microbiology)	31	24.60%
BS Bio (Molecular Biology & Biotechnology)	28	22.22%
BS Bio (Plant Biology)	34	26.98%
BS Biology (Biodiversity)	7	5.56%
Total	126	100.00%

Source. Data analysis result of the research

The universities that the BS Biology students attend are listed in Table 2. The data indicates that 107 or 85% of the students are enrolled at Central Mindanao University in Musuan, Maramag, Bukidnon, while 19 or 15% of the students are enrolled at Mindanao State University-Iligan Institute of Technology with a total of 126 respondents respectively. Biophysics is a course available during the second semester of the third year. The survey questionnaires were answered exclusively by fourth-year students and program graduates for the purpose of the study.

Table 2*Frequency Distribution of Demographic Profile of the Biology Students in terms of University Attended*

University attended	Frequency	Percentage
CMU	107	85%
MSU-IIT	19	15%
Total	126	100%

Source. Data analysis result of the research

Table 3 displays the demographic distribution of the respondents according to sex. Out of the 126 total respondents, 82 individuals are female, accounting for 65% of the sample, while 44 individuals are male, accounting for 35% of the sample. Trafton (2014) found that biology is the most popular field among women pursuing graduate studies and academic careers. Approximately 50% of biology graduate students and 40% of biology postdoctoral researchers are women.

Table 3*Frequency Distribution of Demographic Profile of the Biology Students in terms of Sex*

Sex	Frequency	Percentage
Female	82	65%
Male	44	35%
Total	126	100%

Source. Data analysis result of the research

Table 4 displays the respondents' ages. Out of the 126 respondents, the majority (52) are 23 years old, followed by those who are 22 and 21 years old. The reason for this is that students in their third year of the BS Biology program are typically between the ages of 21 and 23. This is because they have completed the senior high school curriculum and typically begin college at the age of 18 or 19. The respondents aged 24 and 20 represent 3% and 2% of the total respondents, respectively.

Table 4*Frequency Distribution of Demographic Profile of the Biology Students in terms of Age*

Age	Frequency	Percentage
20 years old	2	2%
21 years old	21	17%
22 years old	47	37%
23 years old	52	41%
24 years old	4	3%
Total	126	100%

Source. Data analysis result of the research

Table 5 displays the distribution of respondents according to their senior high school strand. The data indicates that majority (110) individuals have graduated from the Science, Technology, Engineering, and Mathematics (STEM) strand. In addition, there are 12 graduates from the General Academic Strand (GAS), while the Humanities and Social Sciences and Accountancy, Business and Management each have 02 graduates. Graduating from the STEM strand in senior high school offers advantages due to its specialized subjects in biology, chemistry, and physics. However, it is important to note that there are also students who come from non-STEM curricula.

Table 5*Frequency Distribution of Demographic Profile of the Biology Students in terms of SHS Strand*

SHS strand	Frequency	Percentage
ABM	2	1.59%
GAS	12	9.52%
HUMSS	2	1.59%
STEM	110	87.30%
Total	126	100.00%

Source. Data analysis result of the research

Table 6*Constructs of Anxiety Manifested by Students*

Construct	Items	Sample statement
1. Anxiety on lack of foundational knowledge	11, 6, 12	If my instructor asked me to explain a physical event from daily life, I would be worried.
2. Anxiety about test-taking and the instructor's presence	13, 21, 24, 22, 19	Being watched by the physics instructor while I am conducting an experiment stresses me out.
3. Anxiety on lack of laboratory skills	7, 8, 9	When preparing an apparatus for a biophysics experiment, I panic about whether I will be able to conduct the experiment or not.
4. Anxiety on lack of self-confidence	17, 23, 20	When the instructor is solving a problem, I worry that the others understand the solution better than I do.

Source. Data analysis result of the research

The table below shows the level of anxiety in relation to a lack of foundational knowledge. An overall mean of 3.33 was obtained, indicating moderately anxious. The statement “I am usually stressed out before biophysics” exam had a mean of 3.49, indicating that students are highly anxious when scheduled examinations are coming. The statements “I am worried about becoming an underachiever in biophysics due to my lack of mathematical knowledge” and “If my instructor asked me to explain a physical event from daily life, I would be worried” had means of 3.33 and 3.18 respectively, both indicating moderately anxious. The lack of foundational knowledge is one of the challenges in learning the sciences. By learning foundational skills and practicing, most students can master their physics materials (Sasa et al., 2021); however, when students lack the basic skills, they tend to be anxious.

Table 7*Anxiety on Lack of Foundational Knowledge*

Lack of foundational knowledge	Mean	SD	Interpretation
I am usually stressed out before a biophysics exam.	3.49	1.03	Highly Anxious
I am worried about becoming an underachiever in biophysics due to my lack of mathematical knowledge.	3.33	1.12	Moderately Anxious
If my instructor asked me to explain a physical event from daily life, I would be worried.	3.18	1.02	Moderately Anxious
Overall	3.33	1.06	Moderately Anxious

Note. Very Low (1.00-1.80), Low (1.81-2.61), Moderate (2.62-3.42), High (3.43-4.23), Very High (4.24-5.00)
Source. Data analysis result of the research

Table 8 displays the level of anxiety of students in relation to test taking and the instructor’s presence. As gleaned from the table, an overall mean of 3.15 was obtained, indicating “moderately anxious”. The statement “taking a biophysics exam usually scares me” had the highest mean of 3.56, indicating high anxiety. Meanwhile, the presence of the instructor while conducting experiments and explaining experimental results in the presence of the biophysics instructor was found to make students feel moderately anxious. One of the aspects of learning that students find very challenging is when they are to be evaluated through paper-based or practical examinations. Moreover, the presence of the instructor makes students nervous, especially when they feel that they are unsure of their answers to questions raised by teachers. The study conducted by Onukwufor and Ugwu (2017) demonstrated a significant correlation between test anxiety and students’ achievement. Similarly, Balogun et al. (2017) discovered that test anxiety had a notable negative effect on students’ academic performance; moreover, pressuring so much anxiety does not assist the student to perform. Rather, it will impact the academic performance cynically (Coon & Mitterer, 2019).

Table 8*Anxiety on Test-taking and Instructor’s Presence*

Test-taking and instructor’s presence	Mean	SD	Interpretation
Taking a biophysics exam usually scares me.	3.56	1.2	Highly Anxious
Compared with other courses, I worry more about succeeding in the biophysics course.	2.95	0.91	Moderately Anxious
I am usually very nervous when I am studying for a biophysics exam.	3.12	1.01	Moderately Anxious

Test-taking and instructor's presence	Mean	SD	Interpretation
Explaining the findings of an experiment that I have conducted in the biophysics lab to the instructor stresses me out.	2.98	0.95	Moderately Anxious
Being watched by the physics instructor while I am conducting an experiment stresses me out.	3.15	1.04	Moderately Anxious
Overall	3.15	1.02	Moderately Anxious

Note. Strongly Disagree (1.00-1.80), Disagree (1.81-2.61), Neutral (2.62-3.42), Agree, (3.43-4.23), Strongly Agree (4.24-5.00)

Source. Data analysis result of the research

An overall mean of 2.89, indicating moderately anxious was obtained for the construct on thinking uncertainties in Biophysics. As shown in Table 9, all three statements are making students moderately anxious about learning biophysics. These scenarios include uncertainty if laboratory activities will be successful, discussion about biophysics with friends, and the thinking of embarrassment when one is unable to answer questions from the instructor. These thinking uncertainties are making students moderately anxious as these may influence their performance in biophysics.

Table 9

Anxiety on lack of Laboratory Skills

Lack of laboratory skills	Mean	SD	Interpretation
I would feel very embarrassed if the instructor corrected the answer that I gave to a biophysics question in front of the class.	2.84	1.07	Moderately Anxious
When preparing an apparatus for a biophysics experiment, I panic about whether I will be able to conduct the experiment or not.	2.93	1.02	Moderately Anxious
Discussing the biophysics laws with my friends outside the school tenses me up.	2.90	1.05	Moderately Anxious
Overall	2.89	1.05	Moderately Anxious

Note. Strongly Disagree (1.00-1.80), Disagree (1.81-2.61), Neutral (2.62-3.42), Agree, (3.43-4.23), Strongly Agree (4.24-5.00)

Source. Data analysis result of the research

Table 10 displays the findings regarding the correlation between students' biophysics anxiety and their lack of self-confidence in handling biophysics. The obtained overall mean of 3.05 is interpreted as "moderately anxious". The three statements within this construct were observed to induce moderate levels of anxiety among students. Among these statements, the one that had the highest mean score of 3.25 was "Trying to read a sentence full of mathematics biophysics formulas involving symbols of which I do not know the meaning scares me a lot." The findings suggest that students exhibit a lack of confidence in comprehending biophysics problems and feel anxious about assisting others, likely stemming from their own lack of confidence. The presence of low or insufficient self-confidence can be attributed to various factors that result in the development of anxiety.

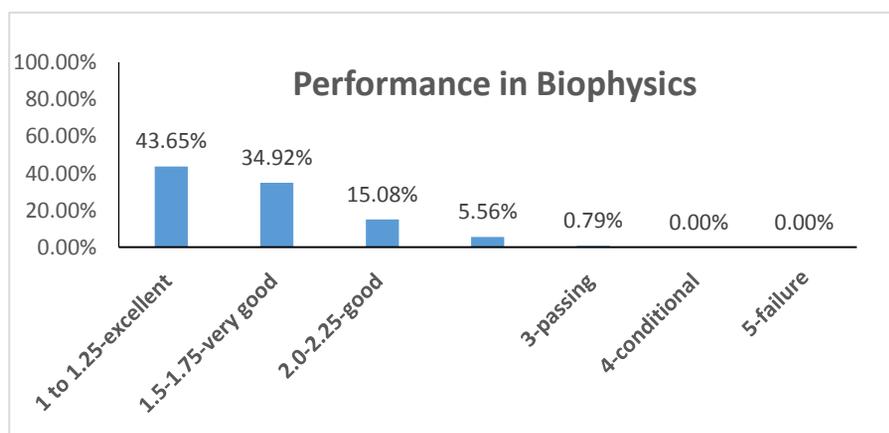
Table 10*Anxiety on lack of Self-confidence*

Lack of Self Confidence	Mean	SD	Interpretation
17. When the instructor is solving a problem, I worry that the others understand the solution better than I do.	2.95	1.04	Moderately Anxious
20. Helping a primary school student with her/his biophysics project tenses me up.	2.95	0.99	Moderately Anxious
23. Trying to read a sentence full of mathematical biophysics formulas involving symbols of which I do not know the meaning scares me a lot.	3.25	0.94	Moderately Anxious
Overall	3.05	0.99	Moderately Anxious

Note. Strongly Disagree (1.00-1.80), Disagree (1.81-2.61), Neutral (2.62-3.42), Agree, (3.43-4.23), Strongly Agree (4.24-5.00)

Source. Data analysis result of the research

Figure 1 shows the percentage distribution of the performance obtained by the students in biophysics subject. The majority (43.65%) of the students got the highest grade of 1.0 - 1.25 which means excellent, followed by 34.92% are very good, with a grade ranging from 1.50 - 1.75. In addition, 15.08% got a grade of 2.00 - 2.25 which means good, and 5.56% of the students satisfactorily got a grade range of 2.50 - 2.75. Moreover, a few students got the lowest (0.79%) grade of 3.0 or passing in biophysics. Thus, none of them obtained a grade of 4.0 or conditional and 5.0 or failure in this subject. This implies that students who took biophysics performed well and had a good performance in the subject.

Figure 1*Percentage distribution of the Performance of Students in Biophysics*

Source. Data analysis result of the research

Table 11 presents the influence of the demographic profile on the anxiety among biology students. The results found that in terms of students major, university attended, sex and SHS strand factors has a p-value of greater than 0.05 level of significance. Therefore, there was no significant influence on the level of anxiety in biophysics among biology students. On the other hand, age was significant with a p-value of 0.0280 which is lesser than 0.05 level of significance,

therefore age has an influence on the level of anxiety among biology students which means students with the same age bracket the more they are anxious.

Table 11

Chi-square and Pearson Correlation Test Results on the Influence of the Demographic Profile on the Level of Anxiety among Biology Students

Demographic profile	Level of Anxiety		
	R-value	p-value	Remarks
Course and Major (X^2)	24.26	0.0840	Not Significant
College/University Attended (X^2)	3.68	0.4508	Not Significant
Sex (X^2)	5.20	0.2677	Not Significant
Age (r_p)	0.1958	0.0280	Significant
SHS Strand (X^2)	9.61	0.6501	Not Significant

Note. Legend: Significant - p-value < 0.05 level of significance, Not Significant - p-value > 0.05 level of significance
Source. Data analysis result of the research

Table 12 reveals the influence of the level of anxiety based on different constructs on the performance of biology students. The results found that the level of anxiety does not significantly influence the performance of biology students since all of the constructs have a p-value of greater than 0.05 level of significance such as construct 1 with a p-value of 0.0680, construct 2 with 0.1652, construct 3 with 0.03040 and construct 4 with 0.3903 respectively. This means that the level of anxiety in terms of constructs and performance of students have a weak relationship. It implies that the level of anxiety is not an indicator of the performance of students in biology. Thus, it does not support and contradict the study of Atsuwe and Chagga (2021), which investigated the effect of physics anxiety on the academic performance of physics education students and showed that there is a significant relationship between physics anxiety and students' academic performance. Students with negative anxiety will perform poorly compared to students with positive anxiety. Students frequently complain about biophysics anxiety and poor academic performance in biophysics classes, and failure situations are known to elicit anxiety responses.

Table 12

Regression Analysis Test Results on the Influence of the Level of Anxiety on the Performance of Biology Students

Constructs	Performance		
	R^2	p-value	Remarks
Anxiety on Lack of Foundational Knowledge	0.0266	0.0680	Not Significant
Anxiety on test-taking and instructor's presence	0.0155	0.1652	Not Significant
Anxiety on lack of laboratory skills	0.0085	0.3040	Not Significant
Anxiety on lack of self-confidence	0.0060	0.3903	Not Significant

Note. Legend: Significant - p-value < 0.05 level of significance, Not Significant - p-value > 0.05 level of significance
Source. Data analysis result of the research

5. Conclusions & recommendations

The study determined the level of biophysics anxiety and its relationship with students' performance among BS Biology Majors. The result of the study is only limited to biophysics students in two state universities in Mindanao. Overall, the college students were reported to be moderately anxious about the lack of foundational knowledge, test-taking, and instructor's presence, lack of laboratory skills, and lack of self-confidence. The demographic profile of students has no significant influence except age on the level of anxiety among biology students in biophysics subject. Moreover, there was no significant influence on the level of anxiety of the four constructs and the performance of biology students. The level of anxiety in terms of constructs and performance of students have a weak relationship. Thus, the level of anxiety is not an indicator to the performance of students in biology. An in-depth investigation may be proposed to determine more factors that may contribute to anxiety aside from the constructs used in this study.

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