

Knowledge and Attitude towards Statistics and Probability of Senior High School Students

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Abstract – The study aims to investigate the knowledge and attitude towards Statistics and Probability of senior high school students, both public and private at the municipality of Magalang, Pampanga. A 25-point multiple choice exam which was based on the Statistics and Probability curriculum of the Department of Education K to 12 program and a 20-item five-point Likert scale attitude questionnaire were administered to randomly selected 397 senior high school students from different strands. The study made use of descriptive-correlational and cross-sectional methods of research. Results showed that students all agree on all the positive attitude statements but mostly are undecided on the negative statements. The study also revealed that students have anxious feelings when they study Statistics and Probability. Students were found to perform unsatisfactorily in Statistics and Probability. The study showed that the students' strength knowledge is on estimation of parameters and sampling distribution categories, but they are weak on fundamentals, random variables, normal distribution, and tests of hypothesis categories. Subsequently, students who belong to the Science, Technology, Engineering, and Mathematics (STEM) strand perform best when compared to those students from the other strands. Also, students from private schools perform better and have a more positive attitude towards Statistics and Probability. Moreover, the study revealed that there is a low but positive and significant relationship between the knowledge and attitude of students towards Statistics and Probability. The study recommends the development and conduct of learning interventions to improve the students' knowledge and lessen their anxiety in learning statistics and probability.

Keywords – Attitude, knowledge, senior high school students, statistics and probability

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INTRODUCTION

The Enhanced Basic Education Act of 2013 (R.A. 10533) led to the creation of the Senior High School program, also known as the K to 12 Program of the Department of Education (DepEd) in the Philippines. It has additional two years of basic education which aims to provide sufficient time for mastery of concepts and skills, develop lifelong learners, and prepare graduates for tertiary education, middle-level skills development, employment, and entrepreneurship [1]. Senior high school students may choose a career track and strand that will define the content of the subjects a student will take in Grades 11 and 12.

One of the core curriculum subjects in senior high school is Statistics and Probability. Offered in Grade 11, the said subject is composed of basic tools (such as summary measures and graphs) for describing data, random variables, normal distributions, sampling distributions, descriptive and inferential statistics, test of hypothesis, and correlation and regression [2]. The competencies gained by students in this course will help them become more statistical literate and obtain skills on data management and analysis in this very data-centric world [3]. Statistics and probability will help students more understand the info world and be able to make correct explanations, conclusions or predictions. The offering of statistics and probability in the Senior High school provides this knowledge to the students and prepares them for their future learnings in college. Hence, investigating the knowledge gained by the students in this course is necessary to assess if the goal had been achieved.

However, Kandeel's [4] study showed that students face a large number of academic difficulties in learning statistics and probability, and this is due to the weakness of their mathematical and statistical background. These academic difficulties are concentrated in the lessons of permutation, combination, probability, and random variable. The results indicated that all the academic difficulties

surveyed by instructors occurred at the “high” or “very high” level and that no difficulty was located at the medium or low levels. His study agreed with Garfield and Ahlgren [5] which stated that a large proportion of students, even in college, do not understand many of the basic statistical concepts they have studied and part of this is inadequacies in prerequisite mathematics skills and abstract reasoning. The study also supported the findings of Arum et al. [6] which showed that students have difficulties in solving the probabilistic problem and can be divided into three categories: understanding the probabilistic problem, choosing and using appropriate strategies for solving the problem, and the computational process in solving the problem.

Meanwhile, to gain knowledge and to ease learning, one must also enjoy the process of learning. According to Adnan and Haslisa [7], students' performance in certain subjects depends on their attitude towards the subject and so, a positive attitude towards the subjects will encourage a person to learn the subject much better.

Adnan and Haslisa [7] also added that a students' positive attitude towards learning motivates active participation, critical thinking, improved interaction and communication skills. In line with this, Tan et al. [8] stated that positive attitudes about learning mathematics and probability have a positive effect on developing understanding the subject. This was supported by Oliveira Junior et al. [9] who stated that students' attitudes and beliefs can impede (or assist) learning statistics and may affect the extent to which students will develop useful statistical thinking skills and apply what they have learned outside the classroom.

Meanwhile, Mata et al. [10], looked into how interrelated variables such as background, motivation, and social support could lead to an explanation of student attitudes towards Mathematics and the defining characteristics of these attitudes in the school environment. It was revealed that students held positive attitudes towards Mathematics and highlighted the main effects of grade and Math achievement on these attitudes

However, according to Judi et al. [11], statistics courses are often considered difficult because it involves many fundamental concepts and techniques. Also, a study conducted by Oliveira Junior et al. [9] showed that students have a negative attitude on the Probability and Statistics subject. They emphasized that there is an indication that students lack confidence in solving statistical and probabilistic problems. This

was done using the Auzmendi Scale composed of five basic factors (utility, anxiety, trust, pleasure, and motivation) in investigating the relationship between the attitude and academic achievement of students.

According to Ashaari et al. [12], there are six factors contributing to the students' attitude towards statistics course which are affective factor, cognitive capability, value, difficulty, interest, and student's effort. They added that the students showed a highly positive attitude in making necessary efforts to understand the subject better.

In a study conducted by Mills and Raju [13] on the attitude of students towards Statistics, there were more positive attitudes towards statistics courses, particularly the introductory statistics courses, compared to negative attitudes. In addition, the results of Ashaari et al. [12] supported this discovery whereas students have a positive attitude in learning statistics course but demonstrated some negative attitude towards the said subject.

Meanwhile, one of the key factors of students having a lower attitude towards statistics is anxiety. And according to the study conducted by Peiro-Signes et al. [14], negative attitudes towards statistics increased the levels of anxiety and consequently reduced the achievement. They also added that attitude towards the said discipline significantly affects performance among students.

Knowledge gained by and manifestation of positive attitude towards learning of the students signify the effectiveness of teaching and learning process. Ashaari et al. [12] emphasized that a study on the student's attitude towards the statistics subject is important to encourage students to understand the statistics concept, to improve their skill in statistics and to appreciate the knowledge in their daily lives. In this regard, the study at hand would be looking into these aspects and would determine the knowledge gained by students and their attitude towards the course Statistics and Probability.

OBJECTIVES OF THE STUDY

The present study aims to determine the knowledge and attitude of senior high school students in Magalang, Pampanga towards Statistics and Probability. Specifically, it aims to: describe the attitude of SHS students towards Statistics and Probability; describe the knowledge of SHS students towards Statistics and Probability; determine the significant difference among the SHS students on their attitude towards Statistics and Probability when compared in terms of their sex, type

of school, and strand; determine significant difference among the SHS students on their knowledge on Statistics and Probability when compared in terms of their sex, type of school, and strand; and determine the significant relationship between the attitude and knowledge of SHS students.

MATERIALS AND METHODS

Design

The study made use of descriptive-correlational and cross-sectional methods of research to investigate the attitude and knowledge of senior high school students in Statistics and Probability. Descriptive-correlational method is a research design used to describe the variables under consideration and assess their relationship [15] and was used to describe the knowledge and attitude of students towards Statistics and Probability. Cross-sectional method is the research design of collecting data from many different individuals without influencing them [16].

Respondents of the Study

All nine (9) public and private schools at the municipality of Magalang were involved in the study. The student-respondents are the Grade 11 students in different public and private high schools in the municipality. Three hundred ninety-seven (397) out of 1534 total number of students participated in the study. The participants were chosen using stratified random sampling.

Instrument of the Study

To determine the knowledge of the students in Statistics and Probability, a self-made twenty-five-point multiple choice exam was given to the student-respondents. The items were based on the Statistics and Probability curriculum of the Department of Education. The test went through content validation by experts and reliability testing before it was administered to the examinees. The exam obtained a Cronbach's alpha of 0.72 which is considered as acceptable to be used for the study. Meanwhile, to determine the attitude of the student-respondents, the study adopted and modified a 20-item five-point scale attitude questionnaire from Alken [17].

Data Collection Procedure

The study was conducted to nine (9) schools which offered senior high school curriculum in the municipality of Magalang - six (6) public high schools and three (3) private high schools. Among these senior high schools, seven (7) different tracks are offered – General Academic Strand (GAS), Home Economics

Strand, Information and Communication Technology (ICT) Strand, Accountancy, Business and Management Strand (ABM), Science, Technology, Engineering, and Mathematics (STEM) Strand, Agri-Fishery Arts Strand, and Humanities and Social Sciences Strand (HUMSS). Based on the total of 1534 Grade 11 enrolled senior high school students in school year 2019-2020, a minimum sample of three hundred fifty students (350) was determined using the Slovin's formula, but 397 students participated in the study.

Ethical Considerations

The researchers forwarded a letter of request to the different administrators and principals of public and private high schools in Magalang. This is to inform the target student-participants of the research undertaking and the importance of their participation in the study.

Upon approval of each school, the attitude questionnaire was first administered online to the randomly selected students. This was supervised by the respective Mathematics teachers of the students in each school. They were assured of confidentiality and anonymity as respondents and that all procedures of the research ensured protecting data and the names of the participants. After two weeks of retrieval of questionnaires on the attitude, the exam on Statistics and Probability was sent to the teachers for them to administer to their students online via Google form. Each student was given an hour to finish the 25-item test. All data collected was only exclusively available and accessible to researchers.

These ethical principles and guidelines were observed in the conduct of the study to build credibility and integrity not only of the processes or procedures undertaken but also to the results and findings presented in this research paper.

Data Analysis

Descriptive and inferential statistical tools were employed to analyze the results of the study using Statistical Program for the Social Sciences (SPSS) software. The descriptive part was utilized in describing the senior high school students' knowledge and attitude using graphs, frequencies, and means. The inferential part was applied to determine significant differences and relationships among variables. Analysis of Variance, t-test for independent samples and Pearson correlation were also used in the study.

RESULTS AND DISCUSSION

Profile of Senior High School Students

Most of the student-respondents came from public

high schools. There are more females than males as respondents of the study from public high schools while there were an equal number of male and female respondents from the private high schools as shown in Figure 1.

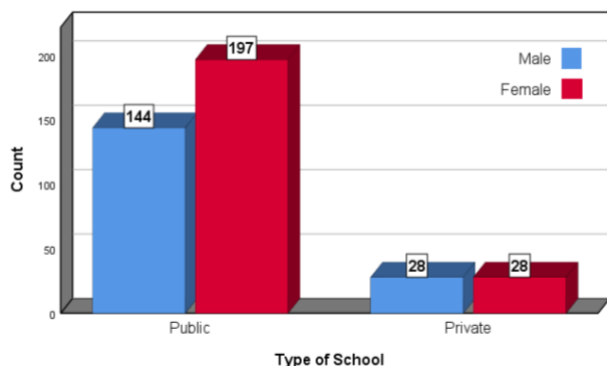


Fig. 1. Type of school by sex by SHS students

Moreover, as shown in Figure 2 most of the respondents belong to the General Academic Strand, while the least number of respondents belong in the Information and Communication Technology strand.

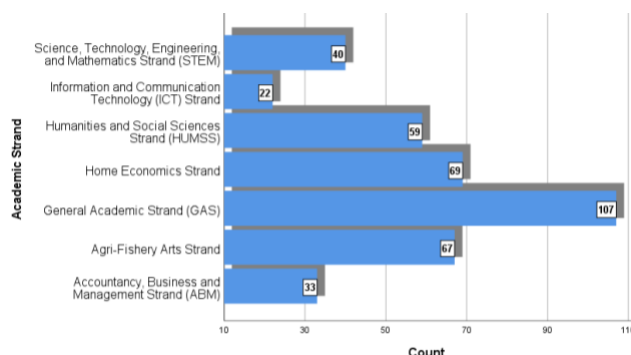


Fig. 2. Academic strand of SHS students

Table 1. Attitude of SHS Students Towards Statistics and Probability

Statements	M	VI ^a
1. I am always under a terrible strain in a Statistics and Probability class.	3.36	Undecided
2. I do not like Statistics and Probability, and it scares me to have to take it.	3.00	Undecided
3. Statistics and Probability is very interesting to me, and I enjoy it.	3.75	Agree
4. Statistics and Probability is fascinating and fun.	3.73	Agree
5. Statistics and Probability makes me feel secure, and at the same time it is stimulating.	3.59	Agree
6. My mind goes blank, and I am unable to think clearly when working Statistics and Probability.	3.30	Undecided
7. I feel a sense of insecurity when attempting Statistics and Probability.	3.29	Undecided
8. Statistics and Probability makes me feel uncomfortable, restless, irritable, and impatient.	3.14	Undecided
9. The feeling that I have toward Statistics and Probability is a good feeling.	3.63	Agree
10. Statistics and Probability makes me feel as though as I'm lost in a jungle of numbers and can't find my way out.	3.25	Undecided
11. Statistics and Probability is something which I enjoy a great deal.	3.66	Agree
12. When I hear the word Statistics or Probability, I have a feeling of dislike.	3.10	Undecided
13. I approach Statistics and Probability with a feeling of hesitation, resulting from a fear of not being able to do it.	3.30	Undecided
14. I really like Statistics and Probability.	3.57	Agree
15. Statistics and Probability is a subject in school which I have always enjoyed studying.	3.54	Agree
16. It makes me nervous to even think about having to do a Statistics and Probability problem.	3.49	Agree
17. I have never liked Statistics and Probability, and it is my most dreaded subject.	3.07	Undecided
18. I am happier in a Statistics and Probability class than in any other class.	3.34	Undecided
19. I feel at ease in Statistics and Probability, and I like it very much.	3.45	Agree
20. I feel a definite positive reaction to Statistics and Probability.	3.64	Agree

Note. M – Mean; VI – Verbal Interpretation; ^a4.20-5.00 – Strongly Agree; 3.40-4.19 – Agree; 2.60-3.39 – Undecided; 1.80-2.59 – Disagree; 1.00-1.79 – Strongly Disagree

Attitude Towards Statistics and Probability

Mean results of the attitude towards Statistics and Probability were presented in Table 1. The highest mean score was obtained by the statement “Statistics

and Probability is very interesting to me, and I enjoy it” ($M = 3.75$). This was followed by the statement, “Statistics and Probability is fascinating and fun ($M = 3.73$), and then by the statement “Statistics and

Probability is something which I enjoy a great deal” ($M = 3.66$). This result shows that the students find Statistics and Probability as enjoyable and fascinating. Moreover, the students all agree on all the positive statements. These present findings were in line with the previous study conducted by Mills and Raju [13] and Oliveira Júnior et al. [9].

However, the study revealed that the students are mostly undecided on the negative statements and agree on the statement “It makes me nervous to even think about having to do a Statistics and Probability problem” ($M = 3.49$). This result shows that the students have anxious feelings when they study Statistics and Probability.

In the study conducted by Ashaari et al. [12], students were found to show a positive attitude towards non-cognitive factors related to the course. Although they find that statistics is a difficult subject, they have put great effort into mastering the concept of statistics. However, in terms of the affective component, the results have shown that the students feel quite intimidated, afraid and stressed in solving problems concerning statistics.

Knowledge on Statistics and Probability

The students obtained a mean score of 8.864 out of 25 perfect score. Figure 3 also shows that the distribution of students’ scores is positively skewed which shows that most of the students obtained scores lower than the mean which is 8.864. This result implies unsatisfactory rating of the students in Statistics and Probability.

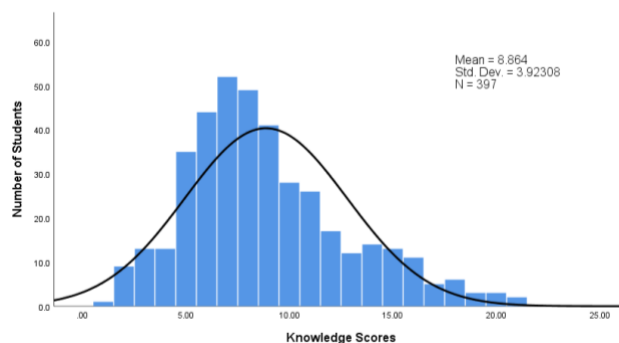


Fig. 3. Distribution of Knowledge Scores on Statistics and Probability

Table 2 shows the percentage correct of respondents in terms of category of topics based on the Statistics and Probability curriculum of the Department of Education. There was a significant difference between the categories of Statistics and Probability, $F(5,2376) = 11.645$, $p < .01$). The results revealed that SHS students have weaknesses in fundamentals/basic topics of 30.48% percentage correct, test of hypothesis ($M = 33.38\%$), normal distribution ($M = 33.50\%$), and random variables and probability distribution ($M = 36.78\%$). Nevertheless, the strengths of SHS students’ knowledge on Statistics and Probability were on estimation of parameters ($M = 42.95\%$) and sampling distribution ($M = 40.55\%$). This result of the study confirmed the findings of Kandeel [4] which shows that students had experienced difficulties in learning topics on Statistics and Probability.

Table 2. Multiple Comparisons of Category of Knowledge Questions

Category	Mean Percentage Correct	F	p
Fundamentals/Basic	30.48 ^d	11.645	.000**
Random Variables and Probability Distributions	36.78 ^{bc}		
Normal Distribution	33.50 ^{cd}		
Sampling and Sampling Distributions	40.55 ^{ab}		
Estimation of Parameters	42.95 ^a		
Test of Hypothesis	33.38 ^{cd}		

Note. Means with the same superscript are not statistically significant at 5% level of significance

* $p < .05$. ** $p < .01$

Difference Among the SHS Students on their Attitude Towards Statistics and Probability

Table 3 shows the significant difference among the variables on the attitude of the student-respondents towards Statistics and Probability. The study revealed

that the attitude of male and female students towards Statistics and Probability are not significantly different, $t(395) = 1.538$, $p = .127$. Students from private high schools have better attitude towards Statistics and Probability than those from the public high schools,

$t(395) = -4.676, p < 0.01$. Students from the Accountancy, Business and Management (ABM) Strand have significantly the best attitude towards Statistics and Probability when compared to those from the other tracks or strands. The rest of the students from the other tracks or strands have comparable attitudes

towards Statistics and Probability, $F(6,390) = 4.738, p < .01$. This discovery corresponds with the results conducted by Ashaari et al. [12] showing no significant difference in attitude among the programs taken by students.

Table 3. Comparison of Students' Attitude towards Statistics and Probability

Variables	<i>n</i>	<i>M</i>	<i>t/F</i>	<i>p</i>
Sex				
Male	172	3.23	1.538	.125
Female	225	3.14		
Type of School				
Public	341	3.12	-4.676	.000**
Private	56	3.58		
Strand				
General Academic Strand (GAS)	107	3.19 ^b	4.738	.000**
Home Economics Strand	69	3.15 ^b		
Information and Communication Technology (ICT) Strand	32	3.03 ^b		
Accountancy, Business and Management Strand (ABM)	33	3.63 ^a		
Science, Technology, Engineering, and Mathematics Strand (STEM)	40	3.02 ^b		
Agri-Fishery Arts Strand	67	3.12 ^b		
Humanities and Social Sciences Strand (HUMSS)	59	3.18 ^b		

Note. Means with the same superscript are not statistically significant at 5% level of significance; * $p < .05$. ** $p < .01$

Difference Among the SHS Students on their Knowledge on Statistics and Probability

The study revealed that the knowledge of male and female students in Statistics and Probability are not significantly different, $t(395) = -1.776, p = .077$. Both distribution of scores in male and female groups are positively skewed which means that the students in both groups obtained low scores in Statistics and Probability as shown in Figure 4.

Moreover, students from private high schools performed better in Statistics and Probability than those from the public high schools, $t(395) = -4.86, p < .01$. Figure 5 shows that both distribution of scores of students from public and private high schools are positively skewed which means that the students in both groups obtained low scores in Statistics and Probability. The gap in knowledge scores is often attributed to different educational inputs and processes in public and private schools as stated by Bernardo et al. [18].

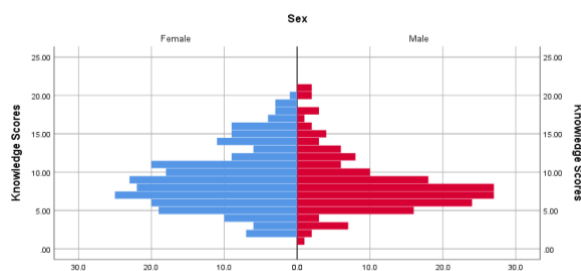


Fig. 4. Distribution of Knowledge Scores of Male and Female SHS Students

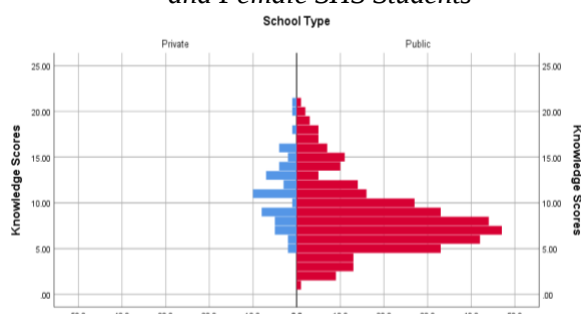


Fig. 5. Distribution of Knowledge Scores of Public and Private SHS Students

Furthermore, students from the Science, Technology, Engineering, and Mathematics (STEM) Strand performed best in Statistics and Probability when compared to those from the other tracks or strands. Second in rank are those from the Accountancy, Business and Management (ABM) Strand. The least scorers came from the Agri-Fishery Arts Strand, followed by the Home Economics and

Information and Communication Technology (ICT) Strands, $F(6,390) = 16.926, p < .01$.

Meanwhile, a study by Retutas and Rubio [19] revealed that among the determinants such as gender, type of school, and Senior High School track, only type of school has a significant difference in terms of self-efficacy beliefs, attitudes towards Statistics, and performance of senior high students in Statistics.

Table 4. Comparison of Students' Knowledge towards Statistics and Probability

Strand	<i>n</i>	<i>M</i>	<i>F</i>	<i>p</i>
General Academic Strand (GAS)	107	9.08 ^{bc}		
Home Economics Strand	69	7.19 ^c		
Information and Communication Technology (ICT) Strand	32	7.55 ^c		
Accountancy, Business and Management Strand (ABM)	33	10.67 ^b	16.926	.000**
Science, Technology, Engineering, and Mathematics Strand (STEM)	40	13.05 ^a		
Agri-Fishery Arts Strand	67	7.09 ^c		
Humanities and Social Sciences Strand (HUMSS)	59	9.10 ^{bc}		

Note. Means with the same superscript are not statistically significant at 5% level of significance; * $p < .05$. ** $p < .01$

Relationship of SHS Students' Knowledge and Attitude Towards Statistics and Probability

A Pearson correlation analysis was used to analyze the relationship between knowledge and attitude towards Statistics and Probability of senior high school students. Based on the SPSS results, the study revealed that there is a significant and positive relationship between knowledge and attitude of students towards Statistics and Probability. However, their relationship is only low ($r(395) = 0.174, p < .01$) and this result confirmed the study of Peiro-Signes et al. [14] and Bond et al. [20].

According to Bond et al. [20], knowledge of statistics of students was significantly associated with how they conceptualized the said subject at the beginning of their course. The findings of the study also confirmed the statements of Adnan and Haslisa [7] and Tan et al. [8] on the positive association between knowledge and attitude of students.

CONCLUSION AND RECOMMENDATION

Based on the findings of the study, the SHS students have a positive attitude towards Statistics and Probability. Students were found to be interested and fascinated with Statistics and Probability, but they feel anxious when they study the said subject. However, students had unsatisfactory ratings in Statistics and Probability most particularly on fundamentals/basic topics. The attitudes of male and female students were

comparable. Students in private schools have better attitudes than those in the public schools. Students from the Accountancy, Business and Management (ABM) Strand had shown having the best attitude when compared to other students from other strands.

Moreover, the study found out that students from private high schools performed better in Statistics and Probability than those from the public high schools, while students from Science, Technology, Engineering, and Mathematics Strand (STEM) Strand performed best in Statistics and Probability when compared to those from the other tracks or strands. Additionally, knowledge in Statistics and Probability was found to be significantly and positively related to attitude towards the said subject.

In line with the conclusions of the study, it is recommended to conduct research on different factors that could affect knowledge retention of students in Statistics and Probability. Since this subject is considered important in the college level and in different lines of work in the future, curriculum planners might revisit the topics included in the curriculum and develop strategies and intervention activities that will enhance the knowledge and attitude of the students towards the said subject more particularly to those students in the non-academic tracks and on basic topics in Statistics and Probability. Further study covering students from other towns and provinces of the country to compare and verify results is also recommended.

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