

# ASSESSMENT OF STUDENTS' STATISTICAL LITERACY IN NORTHWESTERN NIGERIAN POLYTECHNICS

<sup>1\*</sup>Saminu Umar, <sup>2</sup>Kabiru M. Yakubu

<sup>1,2</sup>Department of Mathematics and Statistics, Umaru Ali Shinkafi Polytechnic, Sokoto, Nigeria

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**Abstract:** The aim of this study was to assess the level of statistical literacy among Polytechnic students in Northwest Nigeria using Gal's (2004) model of statistical literacy, which consists of a dispositional component made up of five cognitive elements (literacy skills, statistical knowledge, mathematical knowledge, context knowledge, and critical questions) and a knowledge component made up of two elements (critical stance and beliefs and attitudes). Through the use of a multistage sampling approach, a sample of 1203 students from four (4) polytechnics was selected to participate in a survey. Result from analysis shows that students' statistical literacy on both the knowledge component and dispositional component are all at a moderate level. Additionally, there is a significant difference between the statistical literacy levels of HND and ND students across all sub-components of statistical literacy, except for the sub-components measuring mathematical knowledge and contextual knowledge. This study recommended that instructors and institutions reevaluate and investigate new strategies for teaching and studying statistics in order to help students become more statistically literate.

**Keywords:** Statistical Literacy, Attitudes toward statistics, Northwest Nigeria.

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## I. INTRODUCTION

Statistics is the fundament for planning, monitoring, evaluation, sound reasoning and making right decisions. Statistical literacy is the ability to understand and critically evaluate statistical results that permeate daily life, coupled with the ability to appreciate the contributions that statistical thinking can make in public and private, professional and personal decisions (Wallman, 1993). Chick et al., (2005) describe statistical literacy as 'transnumerative thinking' where students will be able to make sense of and use different representations of data to make sense of the world around them. For Schield (1999), statistical literacy is the ability to read and interpret data: the ability to use statistics as evidence in arguments.

Nowadays information has become more quantitative, readily available and easily obtained, some of this information may be misleading or inaccurate. People often assume a statistic appearing in print or reported on the news is true, which may lead to decision mistake (Ben-Zvi & Garfield, 2004). Processing information and detecting fallacies in result of statistical data presented and interpreted in a biased way requires critical and sound thinking with a cognitive ability for enquiry that can be developed through enhancement of statistical literacy (Kliegr et al., 2021). Statistical literacy helps to critically and efficiently access, consume, digest, react and to the wealth of information being produced, deal with a complex array of issues and participate actively in public debates (English & Watson, 2016). The ability to understand and to apply statistical literacy in decision-making has become essential both in everyday life and effective participation in many professional contexts especially in today's data driven world (Callingham & Watson, 2017).

Learning statistics is concerned with ensuring that students understand statistical ideas and able to apply them in real world situations (Songsore & White, 2018). Callingham (2017) stressed the importance for students to adopt a critical stance about data, referred to as applying statistical literacy. Schools are essential for developing statistically literate pupils who, in turn, comprehend why and how statistics are beneficial in seeing and comprehending the world and its complexity (Frankenstein, 1998). The importance and broad range of applicability of statistics in all educational and collaborative research has led to calls for an increased attention to statistical literacy not only in mathematics curriculum but also in many other disciplines such as medicine, engineering, sports, biology, agriculture, business, economics, education, sociology and many more (Sharma, 2011). Most countries include the study of basic statistical concepts and procedures in their curricula by recognizing the importance of school in the development of statistical thinking and competence in citizen formation (Batanero et al., 1994).

Lack of statistical literacy can easily lead to misunderstandings, misperceptions, mistrusts and misgivings about the value of statistics for guidance in public and private choices (Wallman, 1993). Despite the usefulness and widespread emphasis on learning and teaching of statistics, it is often seen as a daunting subject, and "mathematical anxiety" occurs commonly among students (Perney and Ravid, 1991). Statistics is one of those subjects which students can have a hard time with and have negative attitude towards the subject (Saidi and Siew, 2019). Mills (2004) hinted that literature tends to suggest that students generally have negative attitudes towards statistics. Because of the multifaceted nature of student attitudes towards statistics, a number of researchers have developed instruments to characterize and measure students' statistical literacy and attitudes toward statistics (Nolan et al., 2012), such as Schau et al. (1995) comprehensive instrument for measuring student attitudes towards statistics (SATS-28, and SATS-36), statistical literacy construct by Watson and Callingham (2003), element of statistical literacy by Gal (2004) and a four-stage framework of diagnosing students' thinking in statistical literacy by Sharma et al. (2011).

Numerous researches have attempted to measure and model the features of statistical literacy in different educational contexts, including Yotonygos et al., (2015) who applied the statistical literacy model by Gal (2004) to study the level of statistical literacy of undergraduate students in Thailand through a survey. Their results revealed that the undergraduate students had moderate level of overall statistical literacy, knowledge component and a dispositional component. In the knowledge component, the students had high level of literacy skills and mathematical knowledge, moderate level of statistical knowledge and critical questions, and low level of context knowledge. Additionally, in the dispositional component, the students had moderate level of critical stance, and beliefs and attitudes. Saidi and Siew (2019) conducted a survey research to assess the level of Malaysian students' understanding of the measures of central tendency and attitude towards Statistics. Their results revealed students' understanding of measures of central tendency was at a moderate level, while their attitude towards Statistics was found to be positive.

Oguguo (2020) evaluated data literacy skills of students in Southern Nigerian institutions of higher learning through survey. The researcher applied descriptive statistics, t-test and Analysis of variance to analyze the data, his findings revealed that the students possessed moderate level of data literacy skills. Furthermore his findings revealed that Ph.D. students had better data literacy skills compared to M.Sc. and B.Sc. students, while M.Sc. students' had better data skills compared to B.Sc. students. Idehen (2020) assessed and documented right conceptions and misconceptions of five basic concepts in statistics by Senior Secondary Schools students across Edo State, Nigeria, through survey and analyzed the data using frequency counts and percentages. Results from his analysis showed low students' right conceptions of basic statistical concepts and with majority of students having some nine misconceptions.

Hassan et al., (2020) examined the statistical literacy of university students at BS level by conducting a Quantitative survey research from 9 public universities of Khyber Pakhtunkhwa, Pakistan. The researchers assessed the students through a self-developed Instrument for Statistical Literacy (ISL), result from their study demonstrated that students had low statistical literacy at BS level; it was therefore, recommended that Higher Education Commission of Pakistan may include a significant portion of practical work in the approved curriculum at university level for the enhancement of statistical literacy. Nahdi et al., (2021) used descriptive qualitative method to investigate and describe the statistical literacy of prospective teachers in Islamic Religious Education Department of one of the universities in Majalangka, Indonesia, based on statistical literacy indicators by providing statistical literacy tests to a randomly selected sample of 32 students. Their results showed that 81.25% of students were able to understand statistical data which was displayed in the form of a line diagram; 87.50% of

students can present the data in the appropriate diagram, and only 37.50% of students are able to interpret the data from the given cases.

## II. MATERIAL AND METHODS

This study target population was Polytechnic students in Northwest Nigeria. Participants were chosen from four institutions using purposive sampling and simple random sampling techniques, participation was voluntary and all participants were granted anonymity and confidentiality. Statistical literacy model proposed by Gal (2004) was adopted to examine statistical literacy of the students. The model assumes that students' statistical literacy involves seven elements separated into knowledge and dispositional components. The knowledge component comprises of five cognitive elements: literacy skills, mathematical knowledge, statistical knowledge, context knowledge and critical questions. Dispositional component comprises of two elements: critical stance, and beliefs and attitudes. Five key elements of the knowledge component required for statistical literacy proposed include knowing why data is needed and how data can be produced; familiarity with basic terms and ideas related to descriptive statistics; familiarity with basic terms and ideas related to graphical and tabular displays; understanding basic notions of probability and knowing how statistical conclusions or inferences are reached. While the two elements of the dispositional components include individuals' perception of how they respond to statistical messages in the media and their attitudes toward statistics which affect their belief systems.

The method of assessment that was utilized to evaluate these seven elements was made up of ten multiple-choice questions or ten statements on a 5-point Likert scale (Likert, 1932) under each element. Accurate response received one mark, while erroneous responses received a score of zero and students' statistical literacy was assessed using their overall scores on all seven elements. To offer additional insight into factors that may influence student statistical literacy and attitude towards statistics, demographic information was also collected (age, gender, ethnicity, institution and level of study). Descriptive statistics, mean and standard deviation were employed and class restriction was the basis for making conclusions on literacy level, while comparison was done using independent t-test.

## III. RESULTS AND DISCUSSION

A total of 1203 students participated in the study with a mean age of  $23.11 \pm 4.502$  years. Table 1 shows the demographic information of the participants, in general, there are 784 (65.17%) male and 419 (34.83%) female, the table also shows that 400 (33.3%) of the respondents were in their Higher National Diploma (HND) and 803 (66.7%) were in their National Diploma (ND). Furthermore, a total of 437 (36.33%) students were from Umaru Ali Shinkafi Polytechnic, Sokoto, 321 (26.68%) were from Waziri Umaru Federal Polytechnic Birnin Kebbi, 127 (10.56%) were from Binyaminu Usman Polytechnic Hadeja and 318 (26.43%) were from Kaduna Polytechnic.

**Table 1: Demographic Information**

Gender		Level of study	Total		
			HND	ND	
<b>Male</b>	Name of Institution	Umaru Ali Shinkafi Polytechnic	89	201	290
		Waziri Umaru Federal Polytechnic	76	135	211
		Binyaminu Usman Polytechnic	33	51	84
		Kaduna Polytechnic	69	130	199
	Total		267	517	784
<b>Female</b>	Name of Institution	Umaru Ali Shinkafi Polytechnic	44	103	147
		Waziri Umaru Federal Polytechnic	38	72	110
		Binyaminu Usman Polytechnic	16	27	43
		Kaduna Polytechnic	35	84	215
	Total		133	286	419
<b>Total</b>	Name of Institution	Umaru Ali Shinkafi Polytechnic	133	304	437
		Waziri Umaru Federal Polytechnic	114	207	321
		Binyaminu Usman Polytechnic	49	78	127
		Kaduna Polytechnic	104	214	318
	Total		400	803	1203

Result in Table 2 shows that students' statistical literacy on both the knowledge components and dispositional components are all at a moderate level. Additionally, there is a significant difference between the statistical literacy levels of HND and

ND students across all sub-components of statistical literacy, except for the sub-components measuring mathematical knowledge and contextual knowledge, where p-values were higher than 5% significance level

**Table 2: Mean and Standard Deviations of Statistical Literacy**

Statistical literacy	Overall		Level of study							
	Mean	S.D	Level	HND		ND		Mean Difference	t	p-value
Mean				S.D	Mean	S.D				
Literacy skill	5.75	2.357	Moderate	5.99	2.297	5.29	2.410	0.695	4.863	<0.001
Statistical knowledge	3.95	1.529	Moderate	4.08	1.525	3.70	1.507	0.378	4.072	<0.001
Mathematical knowledge	5.87	2.843	Moderate	5.89	2.793	5.83	2.945	0.060	0.347	0.729
Context knowledge	4.19	2.067	Moderate	4.23	2.087	4.12	2.027	0.119	0.942	0.347
Critical Question	4.66	2.272	Moderate	4.87	2.309	4.24	2.135	0.635	4.610	<0.001
Critical stance	5.39	2.595	Moderate	5.67	2.511	4.81	2.669	0.859	5.472	<0.001
Belief and attitude	4.90	1.933	Moderate	4.72	1.853	5.27	2.037	-0.555	-4.734	<0.001

#### IV. CONCLUSION

This study examined the statistical literacy of polytechnic students in northwest Nigeria. The findings showed that the students exhibited a moderate level of literacy across all seven components of Gal's model of statistical literacy. The HND students demonstrated greater Statistical literacy in five of the seven components of statistical literacy than their ND peers. The results of this study indicate that, despite the significance of statistical literacy including data collecting, hypothesis formulation, data analysis, and data visualization and interpretation, Polytechnic students did not seem to have enough of these. It is therefore recommended that teachers who are currently instructing students in statistics subjects should pay more attention and be encouraged to diversify their teaching strategies so that students can practice their statistics literacy through practical work and exercises. This will help students meet the global standard and help them contribute greatly to their society.

#### REFERENCES

- [1] Batanero, C., Godino, J. D., Vallecillos, A., Green, D. R., & Holmes, P. (1994). Errors and difficulties in understanding elementary statistical concepts. *International Journal of Mathematical Education in Science and Technology*, 25(4), 527-547.
- [2] Ben-Zvi, D., & Garfield, J. B. (Eds.). (2004). *The challenge of developing statistical literacy, reasoning and thinking* (pp. 3-16). Dordrecht, The Netherlands: Kluwer academic publishers.
- [3] Callingham, R., & Watson, J. M. (2017). The development of statistical literacy at school. *Statistics Education Research Journal*, 16(1), 181-201.
- [4] Chick, H. L., Pfannkuch, M., & Watson, J. M. (2005). Transnumerative thinking: Finding and telling stories within data. *Curriculum matters*, 1, 87-109.
- [5] English, L. D., & Watson, J. M. (2015). Statistical literacy in the elementary school: Opportunities for problem posing. *Mathematical problem posing: from research to effective practice*, 241-256.
- [6] Frankenstein, M. (1989). *Relearning mathematics: A different "R" –radical mathematics*. London: Free Association Books
- [7] Gal, I. (2004). Statistical literacy: Meanings, components, responsibilities. In D. Ben-Zvi & J. B. Garfield (Eds.), *The challenge of developing statistical literacy, reasoning and thinking* (pp. 47–78). Dordrecht, The Netherlands: Kluwer Academic Publishers.
- [8] Hassan, A., Ghaffar, A., & Zaman, A. (2020). An investigative study on university students' statistical literacy in Pakistan. *sjesr*, 3(1), 159-164.

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- [9] Idehen, F. O. (2020). Assessing Nigerian Secondary School Students' Misconceptions in Five Basic Statistical Concepts. *Contemporary Mathematics and Science Education*, 1(1), ep20003.
- [10] Kliegr, T., Bahník, Š., & Fürnkranz, J. (2021). A review of possible effects of cognitive biases on interpretation of rule-based machine learning models. *Artificial Intelligence*, 295, 103458.
- [11] Nahdi, D. S., Araniri, N., Jatisunda, M. G., Kurino, Y. D., & Cahyaningsih, U. (2021). Statistical Literacy of Pre-Service Islamic Religious Education Teachers. *Jurnal Cendekia: Jurnal Pendidikan Matematika*, 5(2), 900-908.
- [12] Nolan, M. M., Beran, T., & Hecker, K. G. (2012). SURVEYS ASSESSING STUDENTS' ATTITUDES TOWARD STATISTICS: A SYSTEMATIC REVIEW OF VALIDITY AND RELIABILITY. *Statistics Education Research Journal*, 11(2), 103-123.
- [13] Oguguo, B. C., Nannim, F. A., Okeke, A. O., Ezechukwu, R. I., Christopher, G. A., & Ugorji, C. O. (2020). Assessment of Students' Data Literacy Skills in Southern Nigerian Universities. *Universal Journal of Educational Research*, 8(6), 2717-2726.
- [14] Perney, J., & Ravid, R. (1991). The relationship between attitudes towards statistics, math self-efficacy concept, test anxiety and graduate students' achievement in an introductory statistics course. Unpublished manuscript, National College of Education, Evanston, IL.
- [15] Perney, J., & Ravid, R. (1991). The relationship between attitudes towards statistics, math self-efficacy concept, test anxiety and graduate students' achievement in an introductory statistics course. Unpublished manuscript, National College of Education, Evanston, IL.
- [16] Saidi, S. S., & Siew, N. M. (2019). Assessing Students' Understanding of the Measures of Central Tendency and Attitude towards Statistics in Rural Secondary Schools. *International Electronic Journal of Mathematics Education*, 14(1), 73-86.
- [17] Schau, C., Stevens, J., Dauphinee, T. L., & Vecchio, A. D. (1995). The development and validation of the survey of attitudes toward statistics. *Educational and psychological measurement*, 55(5), 868-875.
- [18] Schield, M. (1999). Statistical literacy: Thinking critically about statistics. *Of Significance*, 1(1), 15-20.
- [19] Sharma, S., Doyle, P., Shandil, V., & Talakia'atu, S. (2011). Developing statistical literacy with year 9 students. *Set: Research Information for Educational Research*, 1, 43 -60.
- [20] Songsore, E., & White, B. J. (2018). Students' Perceptions of the Future Relevance of Statistics After Completing an Online Introductory Statistics Course. *Statistics Education Research Journal*, 17(2), 120-140.
- [21] Wallman, K. K. (1993). Enhancing statistical literacy: Enriching our society. *Journal of the American Statistical Association*, 88(421), 1-8.
- [22] Watson, J.M., & Callingham, R.A. (2003). Statistical literacy: A complex hierarchical construct. *Statistics Education Research Journal*, 2(2), 3-46.
- [23] Yotongyos, M., Traiwichitkhun, D., & Kaemkate, W. (2015). Undergraduate Students' Statistical Literacy: A Survey Study. *Procedia - Social and Behavioral Sciences*, 191(July), 2731-2734.