NATURE-OF-SCIENCE AND SCIENTIFIC INQUIRY LITERACY OF FIRST YEAR COLLEGE STUDENTS

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ABSTRACT: *The definitive goal of scientific literacy is to produce scientifically responsible citizens, as researchers or otherwise as regular members of society. Students should participate in a system of education that equips them to make knowledgeable decisions. This study focused on determining the nature of science and scientific inquiry literacy of first-year college students at the University of Northern Philippines during the school year 2020-2021. This utilized the descriptive-correlational research design in determining the students' scientific literacy by component assessment of nature-of-science and scientific inquiry and its relationship to students' profile and perception in learning science. The majority of the respondents are female, graduated from a public national high school, took the Academic track - Humanities and Social Sciences strand in senior high school and have a general weighted average from 80 through 84. Results showed that the students possessed a low level of scientific literacy by a component of nature-of-science and scientific inquiry despite the high level of perception in learning science. A significant negative relationship between students' gender and level of scientific interest indicating that females performed better than males is also revealed. Likewise, senior high school strands and students' scientific literacy also showed a significant negative correlation, showing that non-STEM graduates tend to have higher scientific literacy than STEM students. This negates the expectations of the academe and society on students pursuing science-related courses to be more scientifically knowledgeable. On the other hand, a significant correlation between the general weighted average and scientific literacy was observed, implying that higher academic performance influences scientific literacy.*

Keywords: nature-of-science, scientific inquiry, science perception, scientific literacy

1. INTRODUCTION

Scientific literacy is the comprehension of scientific ideas and procedures necessary for making decisions for oneself, participating in social and cultural activities, and being productive within the workplace. [1].

A crucial part of learning and studying is assessment. Additionally, it is critical when attaining scientific literacy is the primary educational objective. The Organization for Economic Cooperation and Development's (OECD) Program for International Student Assessment (PISA) and the Trends in Mathematics and Science Studies (TIMSS) are two of the most thorough survey databases for assessing the scientific literacy of participating countries worldwide. Additionally, a variety of theoretical frameworks, research agendas, and philosophies have contributed to the development of numerous research methods that aim to evaluate various aspects of scientific literacy, which typically emphasizes one of the following: (1) gauging recall as a result of scientific cognition; (2) evaluating the ability to create connection of scientific principles in non-academic settings; (3) assessing literacy capabilities within a scientific framework; and (4) measuring learners' understanding of the nature-of-science, as well as their knowledge of scientific concepts and interest science and society relates topics [2].

The way the scientific and science education communities have defined the term "nature of science" reflects how ideas about the nature of science have evolved throughout the evolution of science and systematic thinking about science. It was asserted, though, that there is a tolerable degree of generality in the nature of science that is understandable to K–12 learners and pertinent to their everyday lives. The content and history of at least one science discipline, along with related scientific vocabulary, logical and procedural skills, instructions of systematic evidence, scientific hypotheses and dispositions, and substantial scientific misconstructions, will all be known to people with a broad understanding of the nature of science. Scientific inquiry, however, goes beyond the simple acquisition of process skills like seeing, drawing conclusions, quantifying, interpreting, and data analysis, even though it is well tied to scientific processes. Scientific inquiry refers to the development of scientific knowledge through the integration of traditional scientific methods with scientific understanding and scientific and critical reasoning. According to the National Science Education Standards [3], learners should be able to create scientific questions, design investigations, and experiments, and perform them in order to get the data needed to answer the questions. According to the modern perspective of scientific inquiry, the questions influence the methodology, and the methods vary greatly between and within scientific disciplines and fields [4].

Learners must be prepared with essential life skills, such as those of reflective practice, logical reasoning, ICT skills, and problem-solving abilities, in order to compete in a market that is rich and driven by knowledge and technology. These skills are characteristics of scientific literacy as well. Therefore, it's crucial to achieve a certain level of scientific literacy. The need for people to be scientifically literate in order to compete on the international market is thus growing. In our rapidly changing world, everyone must have a certain level of scientific knowledge and expertise to maximize their personal and social potential, regardless of their age, gender, and culture. [5].

2. METHODS

This study utilized a descriptive-correlational research design [6,7, 8]. Samples in this study were chosen from the total population of first-year college students at the University of Northern Philippines officially enrolled during the first semester of the academic year 2020-2021. From the total

turnouts, 371 out of 5,196 first-year students were randomly chosen and represented the whole population, excluding the College of Law and College of Medicine.

Four research instruments were adapted and used. Student Profile Questionnaire is a material intended to collect personal and academic information of the respondents. Perception in Learning Science Rating Scale is a four-point rating scale that determined students' degree of agreement to statements about science. The 35-item Scientific Inquiry Test was intended to assess students' procedural knowledge in conducting a scientific inquiry and Nature-of-Science Test, which is also a 35-item test, was intended to examine students' knowledge to make informed decisions with respect to the ever-increasing scientifically based personal and societal issues.

Frequency and percentage were used to present the number and proportion of students' Mean was used to determine the level of students' perception in learning science and level of nature-of-science and scientific inquiry literacy. A simple linear correlation was used to determine the relationship between students' profile and their level of nature-of-science and scientific inquiry literacy, and between the level of students' perception in learning science and their level of nature-of-science and scientific inquiry literacy.

This study underwent an ethics review with ERC approval number A-543. It follows the principles of privacy and confidentiality, conflict of interest, data protection, informed consent process, sample recruitment, and specimen handling.

3. RESULTS AND DISCUSSION

Profile of the Respondents. Large percentage of the respondents are female (68.5%) and finished their secondary education in a public high school (69.3%). Majority are non-Science, Technology, Engineering, and Mathematics (STEM) graduates (81.1%) and had general weighted average from 90-94 (41.5%).

Level of Students' Perception in Learning Science. Students' perception in learning science is high ($\bar{x} = 2.82$). Student perception towards science learning is used to describe learners' inclination towards the discipline and point out problems in science education that need immediate and long-term actions. Students think science as an important construct in the real world ($\bar{x} = 3.20$). Recognizing the significance of the discipline in one's life maybe rooted from students' exposure to meaningful and challenging science learning experiences. Moreover, the respondents perceive science as a helpful subject in their day-to-day life ($\bar{x} = 3.19$). Patterns of activities they do in school do not create a gap in the activities they do at home. It can be inferred that students perceive school learning in not disconnected or separated from life/home learning [9].

However, the respondents identify science as not one of their top subjects ($\bar{x} = 2.62$). This response can be expected since most of the respondents are non-STEM graduates and are not pursuing science-related courses. Adu-Gyamfi presented various factors that may contribute to lack of interest in science, hence, not considering it as on of their favorite subjects. Compared to other academic subjects, science is difficult [10]. Besides this perception of the subject, reports of dissipating interest in learning science have been conveyed such as shifting from a science major to a non-science courses due to teaching ineffectiveness, inappropriate instructional material utilization, assessment practices that do not reflect actual learning, and overemphasis on low-order thinking skills (i.e., memorization).

Students' Level of Nature-of-Science and Scientific Inquiry Literacy

From a constructivist's point of view, nature-of-science and scientific inquiry are the underlying constructs for effective science and teaching and assessment [9].

Table 1. Mean Score of Students' Level of Scientific Literacy

Components	Mean Score ($\bar{x}$)	Descriptive Interpretation
Nature-of-Science Literacy	*13.75*	*Low Literacy*
Scientific Inquiry Literacy	*11.33*	*Low Literacy*
Over-all Mean	***25.08***	***Low Literacy***

The scientific literacy of the respondents is low as supported by an over-all mean of 25.08. Effective science learning is expected to improve scientific literacy. Belova et. al. presented possible reasons for low scientific literacy including teacher's adequate knowledge and experiences with science teaching methodologies, as well as educational reform implementation. Moreover, students may acquire relevant content knowledge but lack practical and epistemological skill to utilize the concepts in real life problem-solving [11].

Science literacy by component of nature-of-science literacy has a mean score of 13.75 and is interpreted as low literacy. It indicates that the attitudes and beliefs that underpin the advancement of scientific knowledge are poorly understood by students, who also lack awareness of science as a method of knowledge. This would imply a non-reflective learning among science students even if they are doing science investigations. Nature-of-science knowledge cannot be assumed to be developed by merely doing scientific investigations without doing reflection. A connection between science concepts and their application should be established, Learners are expected to think critically and independently. To resolve this, teachers need to properly communicate the concept through effective approaches such as constructivism and inquiry-based [12].

In terms of scientific inquiry literacy, result showed low literacy as supported by a mean score of $\bar{x} = 11.33$. This points out that students have not much understanding of traditional science processes and the combination of these processes with scientific knowledge, scientific reasoning, and critical thinking to develop scientific knowledge [13]. This would also imply that students' have inadequate or lack basic science inquiry skills (i.e., observing, inferring). Science inquiry-based learning can be promoted to address this. Gormally et. al mentioned that using inquiry laboratory instruction, learners valued more genuine science experience, hence, demonstrating development in their scientific literacy [14].

Relationship Between Students' Profile and Scientific Literacy by Component of Nature-of-Science and Scientific Inquiry

Table 2. Relationship Between Students' Profile and Scientific Literacy

		Nature-of-Science Literacy ($\bar{x}$)	Scientific Inquiry Literacy ($\bar{x}$)	Scientific Literacy Overall Mean
Students' Profile	*Sex*	*-.121**	*-.010*	*-.067*
	Type of High School Graduated from SHS Strand	*.047*	*.032*	*.047*
	General Weighted Average (GWA)	*-.093*	*-.085*	*-.106**
		*.342***	*.273***	*.370***

**Correlation is significant at the 0.05 level (2-tailed)*
***Correlation is significant at the 0.01 level (2-tailed)*

There is a significant negative relationship between students' sex and nature-of-science literacy and overall scientific literacy at 0.05 level. It indicates that female students performed better than males. This is not consistent with the findings of Nwosu & Ibe in which male students were shown to outperform female students in scientific literacy [15]. It also refutes the findings in recent research indicating that trends still favor males in scientific literacy [16, 17]. However, according to OECD [18], variations in cognitive capabilities of men and women at the same age exist. Male learners tend to excel in mathematics and while female learners do extremely well in reading, In the same report, no significant difference in science performance by male and female learners is evident.

Additionally, senior high school track and strand is also significantly related to students' scientific literacy. Students who took non-STEM strands have higher literacy compared to graduates of the STEM strand. This negates the findings of Shaffer et. al. that students who are STEM majors perform higher on average compared with non–STEM students [19]. This would also oppose the expectations of the academe and society on students pursuing science-related courses to be more scientifically knowledgeable.

Moreover, the general weighted average of the respondents is significantly related to their scientific literacy at 0.01. This is consistent with the results of Shaffer et. al. in which previous GWA is a significant predictor of scientific literacy performance. It also confirms the work of Oboma that there existed any relationship between scientific literacy and academic performance of students, and it was significant [20]. Students with higher academic performance also have higher scientific literacy.

lationship Between Students' Interest in Science and Scientific Literacy by Component of Nature-of-Science and Scientific Inquiry

Table 3. Relationship Between Students' Interest in Science and Scientific Literacy

	Nature-of-Science Literacy ($\bar{x}$)	Scientific Inquiry Literacy ($\bar{x}$)	Scientific Literacy Overall Mean
Students' Perception in Learning Science	*.086*	*.131**	*.131**

**Correlation is significant at the 0.05 level (2-tailed)*

A significant relationship between students' interest in science and scientific literacy at 0.05 level. It supports the research work of Huang revealing the level of student interest in science is shown to have a significant positive relationship with scientific literacy [21]. The result also echoes the study of Barr et. al. that students who reported less interest in science performed weakly in their scientific literacy [22]. Students who have higher level interests in science tend to have better scores in scientific literacy.

4. CONCLUSIONS AND RECOMMENDATIONS

Based on the findings of the study, students demonstrated a low level of scientific literacy by component of nature-of-science and scientific inquiry despite their high perception in learning science. A significant negative relationship between students' sex and level of scientific literacy indicating that female performed better than males. Non-STEM graduates tend to have higher performance than STEM major students. A significant correlation between general weighted average and nature-of-science and scientific inquiry literacy is also present. This means that higher academic performance influences scientific literacy.

Students' perception of learning science is related to their nature of science and scientific inquiry literacy significantly. Student perception in learning science is a predictor of scientific literacy. Students should participate in a system of education that equips them to make knowledgeable decisions. Teachers must engage or involve their learners in various scientific practices and investigations, record and reflect on their tasks, and connect and construct knowledge out of their experiences.

The researcher then recommends that science instructors and coordinators could review or look into existing programs and instructional methodologies used in teaching science and whether they contribute to promoting scientific interest and literacy among students. Future studies could also investigate the relationship between scientific literacy and students' profile of different age group or year level to see for patterns in these relationships across age or year level. Others could study other variables such as family and friend's influence on students' perception of science and scientific literacy.

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