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Climate Change Competency Assessment: Focus on Lower Order Thinking Skills (LOTS)

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ABSTRACT

In light of the increasingly dire consequences of climate change, fostering environmental literacy within the educational system has become an imperative. By measuring student competency, we can ensure future generations are empowered to become responsible stewards of the environment and active participants in tackling this global challenge. Thus, this study aims to assess the science students' competency in factors that affect climate, the effects of changing climate, and how to adapt accordingly. The subjects of this study were thirty-one (31) science students, third-year and fourth-year students, composed of 8 males and 23 females who have taken the subject Environmental Science. Results show that students have a higher level of knowledge in competencies 1 and 2, namely: (1) Relate species extinction to the failure of the populations of organisms to adapt to abrupt changes in the environment, and (2) Explain how different factors affect the climate of an area. However, the present investigation yielded no statistically significant differences in climate change competency based on sex or year level, suggesting a potentially homogenous knowledge base regarding climate change across the studied demographic.

INTRODUCTION

Future generations acquiring climate change literacy exceed mere knowledge acquisition. It becomes a fundamental pillar of responsible global citizenship as the scientific consensus on anthropogenic climate change strengthens (Çakır-Yıldırım *et al.*, 2023). Assessing student competency in this domain serves a critical purpose. Firstly, a standardized evaluation allows for identifying knowledge gaps and the subsequent adaptation of curricula to ensure a comprehensive understanding of the science, impacts, and mitigation strategies surrounding climate change (Molthan-Hill & Blaj-Ward, 2022). Secondly, such assessments provide valuable insights into the effectiveness of current educational programs, enabling educators to tailor their pedagogy for optimal learning outcomes (Eichinger *et al.*, 2023). Ultimately, by fostering a generation well-versed in climate change, we empower them to become informed decision-makers, responsible consumers, and active participants in addressing this multifaceted global challenge.

Climate change has brought problems to different countries globally in recent years. Due to a lack of knowledge and preparedness about climate change, some other countries are struggling to cope with the different dilemmas that climate change brings. In Kenya, the reason for low agricultural production and a destroyed economy sector such as tourism is mainly the result of the climate extremes that brought Kenya into a high poverty level due to a severe drought, and this is because literacy levels that have not been properly introduced are the reason why they are struggling (Huho, 2015). Moreover, the graduates in the institution in Ghana may not be knowledgeable enough about climate issues due to the limited coverage of knowledge about climate change issues, and the majority of members of their communities are not aware of climatic issues and the factors affecting climate change, especially in health and lifestyle (Boateng, 2015). According to Ofori *et al.*, (2023), the undergraduate students at the University of Ghana, Legon, reveal a lack of basic knowledge and misconceptions about climate change and its factors. Some of the studies on a global scale show that most of the students have insufficient knowledge about climate change and the phenomena it brings, which eventually causes an unprepared individual regarding climate change.

A similar study was found in Nigeria that focused on climate change awareness. The study by Dada and Muhammad (2014) stated that institutions in Nigeria proposed a "Climate Change Curriculum" to give students a precise comprehension of climate change. With this, students in the institution of Nigeria are knowledgeable enough about climate change to become future leaders. Similarly, they conducted a study to measure the knowledge and awareness level of people in Nigeria to reduce community vulnerability. This study was conducted due to the alarming effects of climate change that can be a severe threat, like rising sea levels, specifically in coastal communities worldwide (Akpomi & Vipene, 2016). Furthermore, as we experience the effects of climate change nowadays, Nigerian students examine the impacts of climate change in education, which aims to disseminate knowledge and learnings about climate change among others, which is the concern nowadays to be well prepared for the impact of climate change (Amanchukwu *et al.*, 2015). This shows the importance of awareness and knowledge based on environmental issues, especially climate change. In conclusion, the absence of knowledge about climate can be a problem, especially in

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coping with some environmental issues.

The Philippines is one of the most vulnerable countries to climate change due to its archipelagic character, frequent typhoons, and reliance on agriculture. The country lies within the Pacific typhoon belt and faces a multitude of hydro-meteorological hazards. A study conducted by Malay (2019) stated that during the early childhood education of learners, raising awareness and promoting positive attitudes about climate change should be one of the basic courses. Their results revealed a moderate to high level of awareness on issues concerning climate change. A similar study conducted by Pael (2021) to grade 12 high school students at Negros Oriental reveals that an "average" knowledge level on climate change is exhibited by a larger number of students. However, there is an "agreeable" affective responses from the students to the actions related to climate change (Diquito *et al.*, 2024).. A study employing a survey type of descriptive research with an adapted questionnaire was conducted by Lualhati (2017). The study reveals that the respondents are least competent in ecological foundations while they agreed that they are competent in conceptual awareness, investigation and evaluation, and environmental action skills.

While the Philippines has integrated climate change concepts into its K-12 curriculum, research suggests a gap in student competency. A study in 2023 by Batchar and Abad found that the majority of the pre-service teachers in state universities in the Philippines had average levels of environmental knowledge. This aligns with findings by Espinosa and Caisip (2023) that there is a need to strengthen the presence of climate change education within the curriculum to significantly boost Filipino college students' awareness of the implications of climate change, focusing on the agriculture, coastal resources, forestry, and infrastructures sectors. Furthermore, a literature review by Hoffmann and Muttarak (2020) suggests that current educational approaches may not be effectively translating knowledge into pro-environmental behavior. These combined findings highlight the need for further investigation into the specific factors contributing to the gap in climate change competency among Filipino students.

The escalating crisis of climate change necessitates a community equipped with environmental literacy. Assessing student competency in this domain is paramount for several reasons. Firstly, a well-informed citizenry is essential for fostering critical thinking and informed decision-making regarding climate change and its impact and individual actions. Secondly, evaluating student knowledge allows educators to identify gaps and tailor educational programs to effectively address the complexities of climate change. By measuring student competency, we can ensure future generations are empowered to become responsible stewards of the environment and active participants in tackling this global challenge.

Research Objectives

The main purpose of this study was to assess the science students' competency in factors that affect climate, the effects of changing climate, and how to adapt accordingly. Specifically, it sought to:

1. Determine the profile of the students according to year and sex.
2. Determine the competency level of the students when it comes to climate change in terms of relating species extinction to the failure of the populations of organisms to adapt to abrupt changes in the environment, explaining how different factors affect the climate of an area, and, describing certain climatic phenomena that occur on a global level.
3. Determine if there is a significant difference in the competencies when analyzed by students' profiles.

METHODOLOGY

Respondents

This study was conducted in one school in Davao Del Sur, Philippines, specifically students under the science program. The criteria for selecting the respondents is that the students should have taken the subject GE 15 Environmental Science. Moreover, third-year and fourth-year science students are the respondents in this study since they had already taken the subject in their second year. In addition, a random sampling technique was carried out in this study. This technique is based on the principle of randomly selecting respondents to participate in the study (Languita *et al.*, 2020). Furthermore, respondents who refused to give their informed consent from this study are excluded.

Instruments

This study utilized a researcher-made questionnaire to assess the three competencies among third-year and fourth-year science students. The questionnaire includes 60-item multiple-choice questions divided into three (3) competencies so each competency has 20 items. Furthermore, the item numbers of each competency are divided into three levels namely: remembering, understanding, and applying. Each level was analyzed and interpreted in the results and discussion. The said questionnaire was validated by three (3) experts focusing on teaching environmental science and its related disciplines.

Design and Procedure

A descriptive-comparative research design was utilized in this study. Without manipulating the independent variable, this research design aims to describe the differences between groups in a population (Cantrell, 2011; as cited by Mangoma, 2023). In this study, the researchers considered the demographic profile of the students to determine if there is a significant difference in their climate change competencies when these students are compared according to their demographic profile.

Several processes like questionnaire validation, consent form distribution, conduct of the test, data analysis and lastly, data interpretation has been followed during the conduct of the study. The researchers depends on the availability of the respondents especially the fourth-year science students due to the internship processes they were undertaking. Moreover, after the target number of respondents was obtained, the researchers proceeded with the analysis of data. Mean score, frequency, and Kruskal Wallis Test was used in analyzing the obtained data. In determining the competency level of the respondents (see table 1 (range of means) for an interpretation of the mean score), the mean score was used (Olores *et al.*, 2023). Frequency was used in determining the respondents' distribution. While to determine if there is a significant difference in the climate change competency level when analyzed by year and sex, Kruskal Wallis Test was used.

Table 1: Range of Means

Range of Means	Interpretation
<55	Needs Improvement
56-65	Low Proficiency
66-75	Adequate
76-85	Proficient
86-95	Very Proficient
96-100	Excellent

RESULTS AND DISCUSSION

The study involved university students' competency level on Climate Change with underlying three (3) competencies: (1) Relate species extinction to the failure of the populations of organisms to adapt to abrupt changes in the environment, (2) Explain how different factors affect the climate of an area, and, (3) Describe certain climatic phenomena that occur on a global level. Each competency is subdivided into three (3) levels of knowledge: remembering, understanding, and applying (Bloom's Taxonomy).

This section presents the discussion and interpretation of the data gathered from the chosen institution's third-year and fourth-year science major students using a sixty-item multiple-choice researcher-made questionnaire.

Interpretation of Each Competency and Overall Competency Level of the 3rd and 4th Year Science Students

Table 2 presents the competency level of the 3rd-year and 4th-year science students. The results show that in Competency 1, students got mean scores of 5.36 in the remembering level (7 items), 6.48 in the understanding level (9 items), and 1.87 in the applying level (4 items) garnering an overall mean score of 14.32 and an SD of 2.69. This means that students have a higher understanding level (6.48) on Competency 1 than on remembering and applying levels. Nevertheless, the students have an adequate proficiency (71.61%) on Competency 1 and scores between 11 to 17 (11.63-17.01) out of 20 items.

In Competency 2, students' understanding levels are the highest with a mean score of 5.13 (SD=1.33) which indicates that out of 7 items, test scores are clustered between 4 to 6 (3.8-6.46). However, in the remembering level, the mean score is 5.06 (SD=1.41). This means that the scores are clustered between 4 to 6 (3.65-6.47) out of 7 items. On the other hand, in the applying level, with the lowest mean score of 3.04 (SD=1.13), the scores are clustered between 2 to 4 (1.91-4.17) out of 4 items. Overall, the students have adequate proficiency (71.61%) with a mean score of 14.32 and an SD of 2.69 on Competency 2. This means that the average scores are clustered between 12 to 17 (11.63-17.01) out of 20 items.

In Competency 3, the remembering level has the highest mean score of 5.23 (SD=1.40). This means that out of 8 items in this level, the average scores are clustered between 4 to 6 (4.09-6.37). The applying level comes second when it comes to the mean score (4.03) and has an SD of 1.08 indicating that out of 6 items, the scores are clustered between 3-5 (2.95-5.11). The understanding level has a mean score of 3.29 (SD=1.04) indicating an average score clustering between 2 to 3 (2.25-4.33) out of 6 items. Despite the value of the mean scores, the applying level in Competency 3 has a higher percentage (67.20%) indicating an adequate proficiency compared to remembering and understanding levels with 65.32% (Low Proficiency) and 54.84% (Needs Improvement), respectively.

In comparison, students have a higher level of knowledge in competencies 1 and 2 namely: (1) Relate species extinction to the failure of the populations of organisms to adapt to abrupt changes in the environment, and (2) Explain how different factors affect the climate of an area, with a mean score of 14.32 and an SD of 2.69 for both competencies garnering a percentage of 71.61% indicating an adequate proficiency. On the other hand, Competency 3 has a mean score of 12.55 and an SD of 2.10 garnering a percentage of 62.64% indicating a low proficiency in this competency.

Overall, the performance of the science students (60 items) has a mean score of 40.59 (SD=4.45). This means that the scores of the students are clustered around 36 to 45 (36.14-45.04). The overall percentage of the students' performance is 67.63% indicating an adequate proficiency on climate change. The result shows that undergraduate students' knowledge is only adequate when it comes to climate change and its effects. In connection, the study of Li and Liu (2023) reveals that students' knowledge in public universities in Taiwan is poor when it comes to the negative effects of climate change, and it is because of their limited interest in participating in environmental courses. This means that there are misconceptions behind the lack of knowledge among students, such as confusion about climate change with other environmental issues, and students don't have enough knowledge of climate change (Huxster *et al.*, 2015).

Table 2: Competency Level of Students Taking the Climate Change 60-Item Test

	Indicators	Competency 1	Competency 2	Competency 3
		(n=20 items)	(n=20 items)	(n=20 items)
Remembering	Mean	5.36	5.06	5.23
	SD	1.05	1.41	1.40
	%	76.50%	72.35%	65.32%
	Interpretation	Proficient	Adequate	Low Proficiency
Understanding	Mean	6.48	5.13	3.29
	SD	1.09	1.33	1.04
	%	72.04%	73.27%	54.84%
	Interpretation	Adequate	Adequate	Needs Improvement
Applying	Mean	1.87	3.04	4.03
	SD	0.81	1.13	1.08
	%	46.77%	60.89%	67.20%
	Interpretation	Needs Improvement	Low Proficiency	Adequate
Overall Performance	Mean	14.32	14.32	12.55
	SD	2.69	2.69	2.10
	%	71.61%	71.61%	62.74%
	Interpretation	Adequate	Adequate	Low Proficiency
Overall Performance (n=60 items)	Mean	40.59		
	SD	4.45		
	%	67.63		
	Interpretation	Adequate		

Note: Competency 1 (Remembering = 7 items; Understanding = 9 items; Applying = 4 items)
Competency 2 (Remembering = 7 items; Understanding = 7 items; Applying = 6 items)
Competency 3 (Remembering = 8 items; Understanding = 6 items; Applying = 6 items)

Science Students' Climate Change Competency Level in terms of Sex

Table 3 shows the competency level in Climate Change of the science students of UM Digos College when analyzed by sex. The Kruskall-Wallis test was applied to assess gender-based differences in competency in climate change. The mean rank for males is 12.63 which is lower than that of females with a 17.17 mean rank. This means that the females score higher than the males. On average, women are slightly more concerned about the environment than men, having stronger pro-climate opinions and beliefs (Ballew et. al., 2018).

According to a study conducted by Clayton et. al. (2023), women worried about climate change are significantly higher than men. However, since the asymptotic significance or the p-value is .221, higher than 0.05, the scores between females and males have no significant difference.

Table 3: The difference in the Overall Competency Level of Participants when Analyzed by Sex Using the Kruskall-Wallis H-Test

	Group	N	Mean Rank	Sum of Ranks	Chi-Square	Z	Asym. Sig.
Overall Performance	Male	8	12.63	101.00	65.00	-1.224	.221
	Female	23	17.17	395.00			
	Total	31					

*p<.05**

Science Students' Climate Change Competency Level in terms of Year Level

Table 4 shows the difference in the Competency Level of Participants when Analyzed by Year Level. According to the data above, the 4th year science students perform better than the 3rd year science students with mean ranks of 18.64 and 13.82, respectively. However, to see if there is a significant difference between the year levels, the asymptotic significance (p-value) should be below .05. Based on the computed asymptotic significance value between the two year levels which is .140, higher than the p-value of .05, there is no significance difference

between their overall performance. In connection, Ayanlade and Jegede (2016) stated that students may have poor knowledge about climate change because they are informed more in the media than the level of climate change study taught in universities in Nigeria. According to the study conducted by Ofori *et al.*, (2015), insufficient competencies about climate change can result in an unprepared individual regarding climate change and can lead to misconceptions about it.

Table 4: The difference in the Overall Competency Level of Participants when Analyzed by Year Level Using the Kruskall-Wallis H-Test

	Group	N	Mean Rank	Sum of Ranks	Chi-Square	Z	Asym. Sig.
Overall Performance	3rd Year	17	13.82	235.00	82.00	-1.475	.140
	4th Year	14	18.64	261.00			
	Total	31					

*p<.05**

CONCLUSION

The main purpose of this study was to assess the science students' climate change competency level especially these three sub-competencies: (1) Relate species extinction to the failure of the populations of organisms to adapt to abrupt changes in the environment, (2) Explain how different factors affect the climate of an area, and, (3) Describe certain climatic phenomena that occur on a global level. According to the data, science students have a higher understanding level (6.48) on Competency 1 than on remembering and applying levels. It also seeks to determine the significant differences in the climate change competency level in terms of sex and year level. While conducting the study, researchers face struggles, especially balancing the numbers of males and females. Since, understandably, it is uncontrollable, the researchers still proceeded with the data analysis and suggest to reach samples with equal ratio when determining significant differences in competency level in terms of demographic profiles. The present investigation yielded no statistically significant differences in climate change competency based on sex or year level. This finding suggests a potentially homogenous knowledge base regarding climate change across the studied demographic. However, it is crucial to acknowledge potential limitations. Future research endeavors could delve deeper by examining the influence of socioeconomic background and differential access to environmental education resources. These factors have been documented in prior studies to influence environmental literacy (Stern et. al., 2019, Mónus, 2022). A more nuanced understanding of these potential contributing factors could inform the development of targeted educational interventions aimed at fostering a deeper understanding of climate change across diverse student populations.

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