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# Annals of Studies in Science and Humanities

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# Drying Conditions in a Solar Dryer System and its Influence on the Moisture Content of Dried Banana

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**ABSTRACT**

This work presents the dynamics of solar radiation, temperature, and relative humidity within a five-day period inside and outside a solar dryer. Solar irradiation within the observation period followed a cyclic pattern, peaking midday and fluctuating late afternoon. A similar cyclic trend was noticed for the temperature inside the dryer. Meanwhile, the temperatures measured outside the dryer were significantly lower and showed less distinct increases and fluctuations. Moreover, relative humidity measurements inside the solar dryer revealed more defined fluctuations. A drastic decrease in relative humidity occurred as time approached midday, and an eventual increase was noted towards the evening. Finally, the dynamics of moisture content removal in the banana were observed to be related to the mentioned parameters. Inside the solar dryer, moisture content removal tends to drastically occur at midday when the solar radiation and temperature peak, and the relative humidity is at its lowest. More efficient moisture content removal was observed inside the solar dryer compared to the ambient environment. Interestingly, the daily increment in the reduction of moisture content varies, showing the third day with the most drastic moisture content reduction.

Keywords: *Solar dryer system, moisture content, dried banana, solar radiation, relative humidity*

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## 1 Introduction

Solar drying is a longstanding practice in removing the moisture content of crops and other agricul-tural products (Ndukwu et al. 2023). Technically, solar drying is described as a method of removing moisture from crops or other materials by direct or indirect exposure to sunlight (Rizalman et al. 2023). This method involves solar dryers that use solar heat to remove the moisture from the crops while controlling the environmental conditions, including the humidity and airflow of the system. Typically, solar dryers are designed and employed to isolate the drying environment from the ambient conditions, affording a controllable and efficient drying system (Udomkun et al. 2020). Apart from being cost-effective, solar drying is highly sustainable and environmentally friendly since it exploits renewable energy with no carbon emissions, contrary to fire, mechanical, electrical, or gas dryers. It also improves the hygiene and preserves the quality of crops by protecting them from dust, insects, and other environmental contaminants. Moreover, solar drying systems are highly scalable and can be tailored for home use or scaled up for huge commercial agricultural operations. Although the utilization of solar dryer systems is already an established part of post-production and agricultural systems, optimizations and understanding the interconnectedness of parameters that influence the drying process are still limited (Abdul Razak et al. 2021). These parameters include the airflow and ventilation, dryer architecture, sunlight intensity, drying temperature, relative humidity, and product moisture content (Ruzikulov et al. 2023). Understanding the relationship among these parameters and how they vary at certain periods canmeters and how they vary at certain periods

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can provide valuable insights into optimizing solar drying operations and improving product quality.

Bananas have long been a staple crop in many Asian countries including the Philippines and Thailand (Kraithong & Issara 2021). Its cultivation contributes significantly to the region's agricultural exports and gross domestic product making it a significant crop subject to innovations and research development. In 2025, the market size of bananas is estimated to be around USD 141.97 billion. This is projected to increase to USD 147.74 billion by 2030 (Mordor Intelligence, 2025). Due to its high nutritional value and cultural significance, a number of products have been derived from this fruit, including flavoring powders, banana flours, chips, and dried snacks (Martínez et al. 2024). For instance, dried banana production is growing in the banana-based product industry. The dried banana market globally was valued at approximately USD 1.15 billion in 2023 and is anticipated to grow to USD 1.98 billion by 2033, exhibiting a CAGR of 5.7% from 2024 to 2033 (DataHorizzon Research, 2025). The success of the dried banana industry lies critically in maintaining the quality of the product. Moreover, monitoring the moisture content of the banana during the drying process is also crucial to achieve the desired quality of the product.

In this study, we analyze the behavior of key drying parameters in a solar dryer system over specific time windows, with a focus on solar radiation, temperature, and relative humidity during a five-day period. The dynamics of these parameters within a typical solar day are also explored to understand their impact on drying efficiency better. Additionally, we examine the effect of solar drying on the moisture content of dried bananas and provide a comparative analysis with samples dried under open-air conditions. While a related work focusing on drying tomatoes in the same solar dryer design with similar drying parameters has already been published, no work has been published concerning the drying of bananas in the same dryer This investigation, therefore, aims to enhance understanding of the factors influencing solar drying per-formance with banana for future optimization and enhanced solar drying strategies.

## 2 Materials and Methods

### *2.1 Solar dryer setting and design*

The solar dryer used in this study was a mixed-mode solar dryer, combining both direct and indirect solar radiation. The dryer consisted of a transparent polycarbonate cover, a black-painted absorber plate, and a drying chamber. The dimensions of the dryer were 20m x 8m x 3.5m (L x W x H). This design was chosen based on recent advances in solar dryer technology that optimize energy efficiency and drying uniformity. The illustration of the solar dryer with various perspectives is presented in Figure 1.

The heat transfer in a solar dryer occurs in three primary mechanisms: conduction, convection,

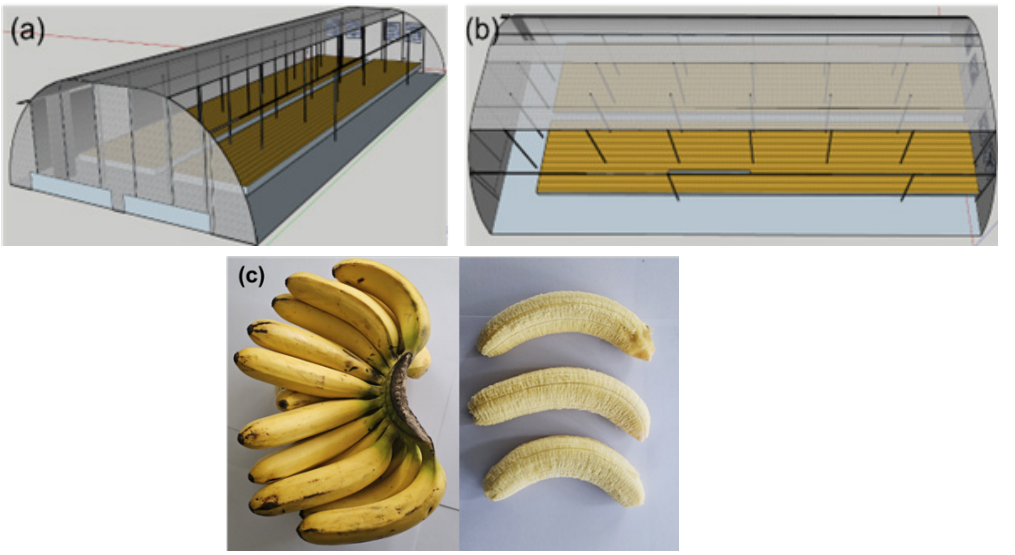


Figure 1. Illustration of the (a) two-point perspective and (b) top-view perspective of the drying environment inside the solar dryer. (c) Photograph of the actual banana samples used in the study.

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and radiation. Each mechanism contributes to the drying process by facilitating the transfer of heat from the sun to the product being dried as well as the subsequent removal of the product's moisture content. Figure 2 presents the schematic diagram of energy transfer within the solar dryer, where $V_{in}$ and $V_{out}$ represent the inflow and outflow of the air, while $h_c$ and $h_w$ represent the coefficients of convection in the cover and due to wind, respectively. The coefficient of radiation is represented by $h_r$.

### *2.2 Instrumentation and Parameter Measurements*

Fresh bananas (Cavendish, *Musa acuminata*) were obtained from a local farm as shown in Figure 1c. The bananas were peeled, sliced to 5mm thickness, and divided into two groups: solar drying

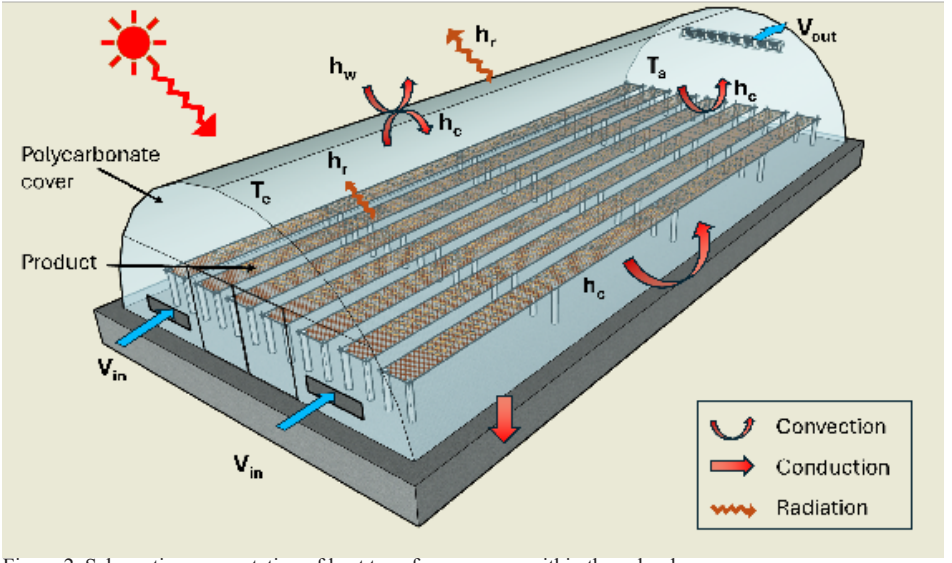


Figure 2. Schematic representation of heat transfer processes within the solar dryer

and open-air drying (control). The drying process was conducted over five consecutive days in the first half of August. Measurements were taken hourly from 7:00 AM to 6:20 PM each day. Solar radiation (W/m²) was measured using a pyranometer (Kipp & Zonen CMP3, accuracy ±5%). Temperature was recorded inside and outside the dryer using Type-K thermocouples (accuracy±0.75%). Relative humidity (RH) was measuredinside and outside the dryer using capacitive humidity sensors (Vaisala HMP60, ±3%). For the moisture content, the banana samples were placed in the dryer at fixed positions. They were weighed periodically at about two-hour intervals using a digital balance (Kern 474-42, accuracy ± 0.1 g). Controlled samples (open-air, sundried) were also weighed at similar intervals and compared against the samples dried in the solar dryer. The moisture content was estimated by comparing the difference between the mass of the banana samples before and after each measurement. During the observation period, the air flow speed was maintained at 0.5 m/s using a DC fan controlled by a micro-controller to ensure consistent ventilation.

### *2.3 Statistical Analysis*

The statistical analysis of the dataset, including temperature, relative humidity, and moisture content of the samples dried using the solar dryer and the traditional drying method, was conducted using JASP software. Upon analysis, it was determined that the dataset did not satisfy the assumptions required for parametric tests, such as normality and homogeneity of the variances. As a result, a nonparametric alternative was chosen. The Mann-Whitney U test was applied to compare differences between groups for each variable. The Mann-Whitney U test is particularly suitable for non-normally distributed data as it evaluates whether one group tends to have higher or lower values compared to another without relying on the assumptions of a normal distribution. [*Field, A. (2013). Discovering Statistics Using IBM SPSS Statistics (4th ed.). SAGE Publications.*]

Data preparation and analysis of the above-mentioned variables in JASP involved the following steps. First, the dataset was imported and inspected for consistency and completeness, followed by exploratory data analysis (EDA) to assess the

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distribution of variables and identify potential outliers. Then, normality of each variable was tested using the Shapiro-Wilk test. At the same time, the homogeneity of each variable was tested using Levene's Test, which confirmed that parametric assumptions were violated. Subsequently, the Mann-Whitney U test was conducted for each variable, with the significance level (α) set at 0.05. The results provided insights into the differences between the two independent groups in terms of their median values, which were further interpreted in the context of the study objectives and discussed in the subsequent sections of the paper.

## 3 Results and Discussions

### *3.1 Variations of solar radiation*

Figure 3 presents the relationship between solar radiation and drying time over a five-day period. The amount of solar radiation (W/m²), which quantifies the sun's energy that reaches the area of interest, was measured within the drying period, starting at around 7:00 AM to 6:00 PM, with data taken at hourly intervals for five consecutive days. The graph shows a repeating pattern of rising solar radiation in the morning and then declining toward the evening. Consistent peaks were observed around midday, corresponding to when the sun is at its highest point in the sky, where there is maximum solar radiation output. Generally, each observed day follows a similar solar radiation pattern, but minimal radiation fluctuations vary slightly from day to day. Moreover, small dips and fluctuations in the solar radiation throughout the day were observed, which could be attributed to the isolated cloud cover or atmospheric conditions that obstruct the sunlight

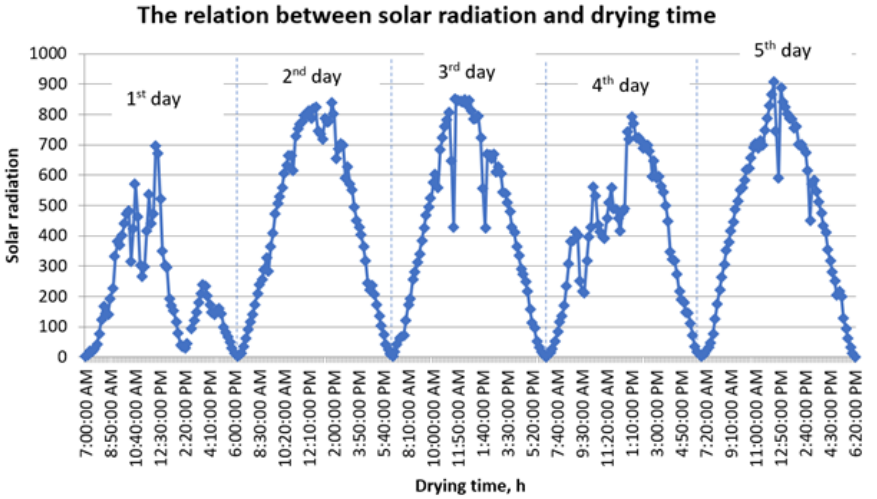


Figure 3. Variations in solar radiation recorded throughout each day over a 5-day period within the solar dryer.

from reaching the ground. These results further imply that higher solar radiation can be harnessed around midday or noon, while lower radiation is available in the morning and late afternoon. This suggests that to maximize drying efficiency, it is necessary to conduct the drying at around midday or noon. These consistent patterns can be used to plan optimal drying times when solar radiation is considered.

### *3.2 Variations of temperature inside and outside (ambient) the solar dryer*

Figure 4 shows the relationship between temperature and drying time inside and outside a solar dryer over a 5-day period. The blue line represents the temperature inside the solar dryer, while the orange line represents the temperature of the ambient conditions outside the dryer. The Mann-Whitney U test was used to assess differences in the temperature between two independent groups, namely the traditional and solar drying method. The test statistic (W) was 3209.500, and the p-value is reported as less than 0.001, indicating a statistically significant temperature difference between the two groups. Since the p-value is smaller than the common threshold of 0.05, we reject the null hypothesis, concluding that there is a significant difference in temperature inside the solar dryer compared to the outside temperature.

Inside the solar dryer, temperatures show a

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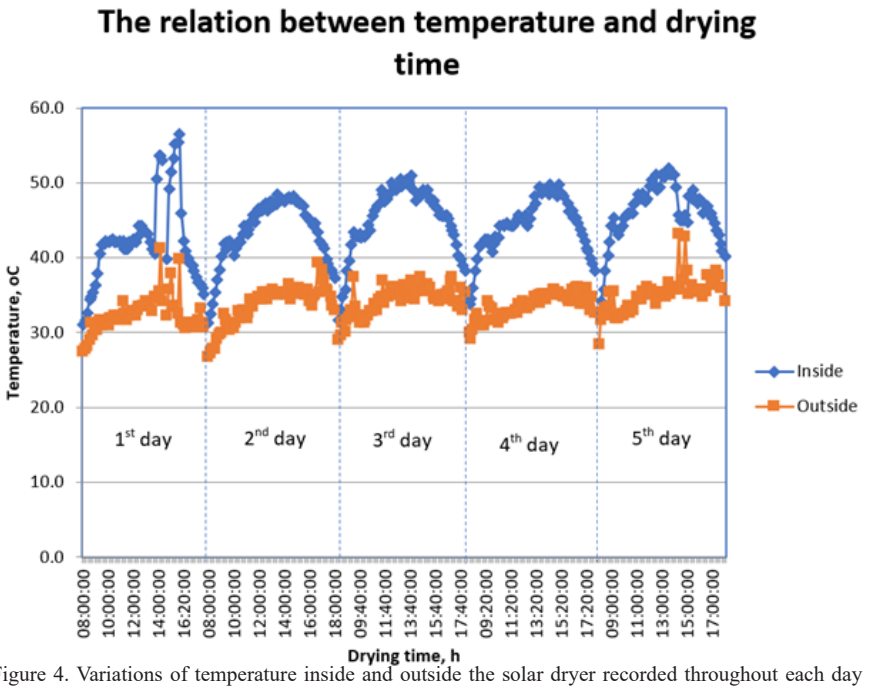


Figure 4. Variations of temperature inside and outside the solar dryer recorded throughout each day over a 5-day period.dryer.

significant daily fluctuation, ranging between 30°C and 55°C, with peaks occurring around midday and declines during the late afternoon and evening. This profile is consistent with the sun's position and solar radiation intensity, which peaks around noon and decreases as the day progresses, suggesting that the solar radiation patterns are more likely to influence temperature dynamics. Meanwhile, ambient (outside) temperatures exhibit smaller fluctuations compared to the temperatures inside the dryer. The external temperatures remain relatively stable, ranging between 25°C and 35°C, only throughout the observation time. The less dynamic temperature variations outside the solar dryer could be attributed to the uncontained radiation and rapid dissipation of heat in the open environment (Shrestha et al. 2019). The difference in the temperature profile between the two locations clearly highlights the amplification effect of the solar dryer in the hourly increase and decrease in temperature. The apparent difference between the fluctuations inside and outside temperatures also indicates the solar dryer's ability to regulate and retain heat (Hegde et al. 2015). Compared to more gradual external fluctuations, the sharp peaks inside suggest that the solar dryer effectively captures and traps solar energy, maintaining higher internal temperatures, even during declining external heat.

### *3.3 Variations of relative humidity inside and outside (ambient) the solar dryer*

Figure 5 shows the relationship between relative humidity and drying time inside and outside the solar dryer over a 5-day period. The blue line represents the relative humidity inside the solar dryer, while the orange line shows the relative humidity in the ambient environment (outside). A cyclical pattern was observed both inside and outside the solar dryer. The Mann-Whitney U test was used to compare the relative humidity between two independent groups, the traditional and solar drying methods. The test statistic (W) was reported as 746.000. The p-value is less than 0.001, which indicates a statistically significant difference between the two groups for relative humidity.

Relative humidity peaks in the evening and early morning hours, both inside and outside the dryer, while it lowers at periods when solar radiation is at its peak. This indicates that the increased temperature provided by the high solar radiation effectively reduces the moisture content of the air in both locations. However, the more pronounced fluctuations inside the solar dryer indicate that the controlled environment efficiently facilitates moisture removal compared to ambient conditions, eventually creating a drier atmosphere for the crops. Moreover, upon closer inspection, the relative

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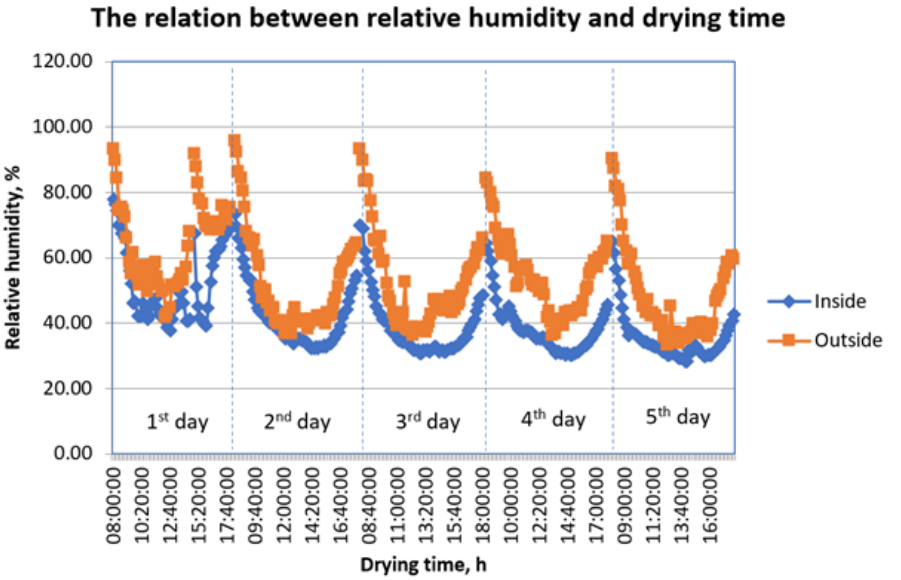


Figure 5. Variations of relative humidity inside and outside the solar dryer recorded throughout each day over a 5-day period.

humidity patterns over the 5-day period were more consistent inside the solar dryer than in the ambient environment, suggesting stable and more predictable RH dynamics inside the solar dryer.

Compared to outside conditions, the significant reduction in relative humidity inside the solar dryer during the day creates a more effective drying environment. Lower humidity inside the dryer means that moisture from the crops can evaporate more quickly, improving drying efficiency (Xu et al. 2021). This drier environment inside the dryer accelerates moisture loss from the crops, leading to faster drying times compared to crops left in ambient conditions, especially during peak drying times. The control over humidity is essential for high-quality drying, as it prevents the risk of mold growth and other moisture-related spoilage that can occur at higher humidity levels (Bradford et al. 2018). However, it is worth noting that this behavior is a close consequence of the cyclical pattern of the solar radiation availability. During the day, when solar radiation and temperature increase, the relative humidity inside the dryer drops sharply. Conversely, when temperatures drop and solar energy is unavailable during the night and early morning, relative humidity inside the dryer increases. This further implies that interventions should be done during this period to prevent moisture-related damage and contamination.

### *3.4 Reduction of moisture content in banana inside and outside (ambient) the solar dryer*

The removal of moisture content in bananas inside and outside the solar dryer in a five-day interval was examined and presented in Figure 6. The Mann-Whitney U test was also used to assess differences in moisture content between two independent groups. The test statistic (W) was 558.000, and the p-value is reported to be 0.004, which indicates a statistically significant difference in moisture content between the two groups. Since the p-value is smaller than the common threshold of 0.05, by rejecting the null hypothesis, we can conclude that there is a significant difference in moisture content between the banana placed inside the solar dryer compared to that of the traditional air-drying method.

The moisture content of the banana samples exhibited a consistent reduction down to 15% inside the solar dryer. In comparison, a much higher moisture content of about 25% was retained on the banana dried in the ambient environment. This shows the more efficient drying capacity of the solar dryer. It is worth noting that the third day exhibited the highest removal of moisture content (about 20% reduction) in the solar dryer, highlighting that the third day of drying is crucial in the progression of moisture content removal. Upon closer inspection, we can also see steeper slopes occurring after 8:00 am and before 4:00 pm, indicating that the removal of moisture happens between these periods. Before and beyond these periods, plateaus in the graph were noted, signifying no significant reduction

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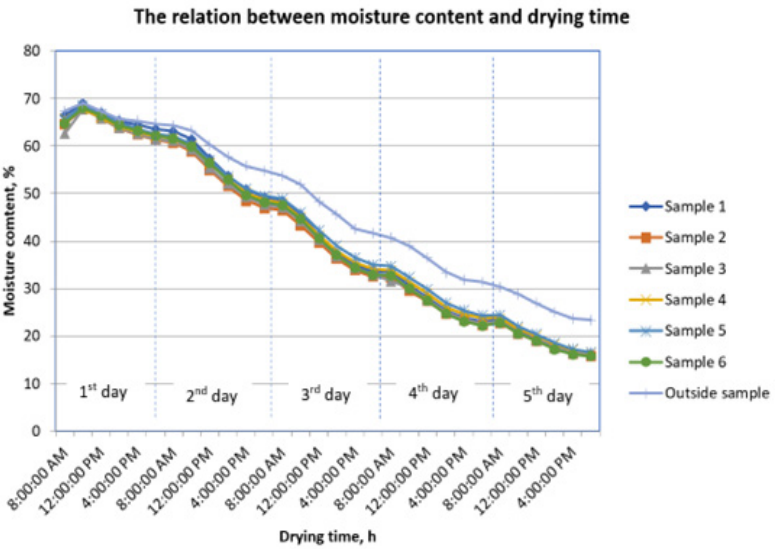


Figure 6. Variations of relative moisture inside and outside the solar dryer recorded throughout each day over a 5-day period.

of the moisture content during nighttime in the solar dryer. It can be noted that when the moisture content was observed to decline drastically at the daily time window, the relative humidity decreased, and the temperature and solar radiation increased. This implies that the drastic removal of moisture in the banana during this period is driven by these conditions. The increase in the solar radiation availability, increases the solar dryer's temperature, and reduces the relative humidity, eventually leading to a more efficient removal of moisture content in the banana. The observed drastic reduction at around midday, where the increase in solar radiation and temperature is at the peak, further supports this observation. This relationship may not be very defined in the moisture content removal in the banana conducted in the ambient environment (outside) due to the minimal fluctuations in the ambient temperature.

While more detailed in situ physical and chemical characterizations are required to inspect this phenomenon, we speculate a number of possible reasons for this observation. The first reason could be attributed to the rapid moisture evaporation in the first three days. This moisture content possibly originates from the superficial moisture of the banana. After the third day, significant moisture content was removed, and the moisture bound within the cellular structure of the banana was left, making the succeeding moisture reduction slower. On another perspective, the moisture content inside the fruit decreases as the banana dries, reducing the difference in vapor pressure between the banana and the surrounding air. This lower gradient slows down the drying process, particularly beyond the third day. Moreover, if the banana dries, it develops a drier and harder outer layer that may act as a barrier that prevents moisture from evaporating inside the banana. This further reduced the drying efficiency after the third day.

The daily moisture removal rate was determined and presented in Figure 7. Both samples, dried both within and outside the solar drying system, exhibited a positive slope in the moisture removal curve, indicating a continuous loss of water throughout the drying process. Notably, the samples dried within the solar dryer demonstrated a significantly higher daily moisture removal rate compared to those dried outside. This observation is consistent with the observed drying conditions inside the dryer, wherein higher temperatures and a reduction in humidity were observed. Lower humidity creates a steeper moisture gradient between the sample and the surrounding air, driving faster water evaporation. The enhanced air movement in the chamber may also help remove the moisture in the drying environment and the samples, resulting in drier air, and promoting faster evaporation. This suggests that the solar drying system effectively enhanced the drying kinetics.

## 4 Summary and Conclusion

We analyzed the dynamics of solar radiation, temperature, and relative humidity over a five-day period inside and outside a solar dryer. Solar radiation exhibited a cyclic pattern, peaking midday and fluctuating in the afternoon.

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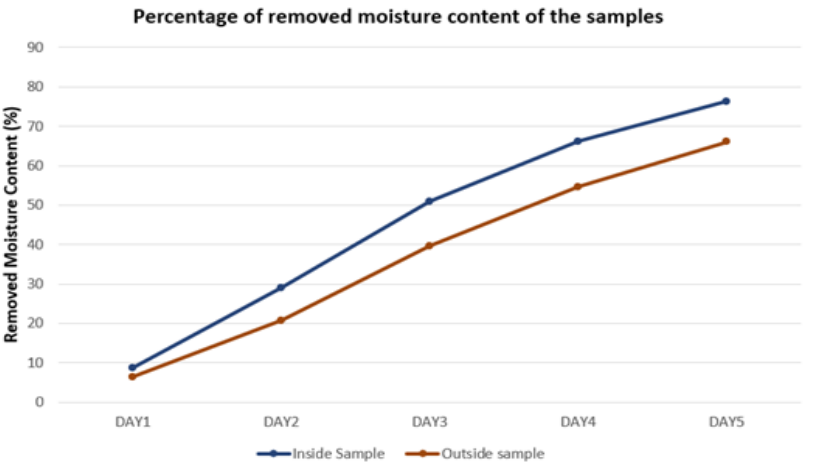


Figure 7. Variations of relative moisture content removed from the samples inside and outside the solar dryer recorded throughout each day over a 5-day period.

Temperature inside the dryer supported this trend, whereas outside temperatures were lower and showed less pronounced fluctuations due to rapid heat dissipation in the open environment. Relative humidity inside the dryer inversely correlated with temperature, decreasing sharply at midday and rising in the evening, which could be associated with the consistent moisture removal facilitated by higher temperatures. Moisture content in bananas decreased most significantly at midday when solar radiation and temperature peaked, with minimal changes during the evening and early morning. Notably,the third day exhibited dramatic moisturereduction, while the second, fourth, and fifth days showed consistent trends. These findings demonstrate the critical interplay of solar radiation, temperature, and humidity in optimizing drying efficiency. They also highlight the advantages of a solar dryer over ambient drying by providing controlled conditions that enhance moisture removal and reduce drying duration.

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# POLICY BRIEF

# Beyond Extraction:

## Addressing Health and Equity Concerns in Surface Mining Communities of Libjo, Dinagat Islands

*Policy pathways to address perceived health risks, service gaps, and inequities in mining-affected communities of Libjo, Dinagat Islands*

### What's the concern?

Mining is important for the economy, but it also causes pollution, like dust and other harmful materials, when it digs, crushes, transports, and processes minerals [1].

Mining communities and nearby residents often suffer from health problems like respiratory diseases, lung cancer, tuberculosis, hearing loss, and skin conditions [2]. These problems are caused by poor air quality and contaminated water, which can lead to short- and long-term health issues for everyone, regardless of age or gender [3].

Libjo, a small coastal town in the southern part of the Philippines, mines nickel on a large scale. Most residents rely on farming, fishing, or mining. Due to its remote location, the public health needs are often overlooked, posing risk to the well-being of its population.

### RESEARCH APPROACH

Key Informant Interviews (KIIs) were conducted in five communities near nickel mines in Libjo and Tubajon. A total of 55 respondents representing key sectors participated in this study, ranging from 21 to 67 years old, and had resided in these communities or were employees of the mining site for at least six (6) months. The goal was to understand how people in different roles perceive the health effects of mining.

## KEY RESULTS

- Mining activities are generally NOT perceived to have adverse effects on the overall health of people in the surrounding communities.
- A majority of respondents report that the health services provided by the nickel mining company are highly beneficial to the community. These services include, among others, improvements to the local water system, provision of free toilets, and access to the company's clinic for community members.
- Residents closer to the mining site perceive its health impacts less positively, suggesting spatial differences in perceived risk.
- Some community members perceive the mining company's health interventions as unevenly distributed across areas.
- Mining activities during peak hours are perceived to affect the air quality in the community, raising environmental health concerns.

*This research was conducted by the faculty-researchers of the College of Mathematics and Natural Sciences (CMNS), College of Engineering and Geosciences (CEGS), and College of Humanities and Social Sciences (CHaSS) of Caraga State University.*

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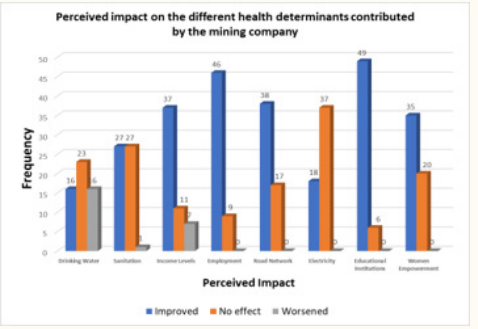
# Beyond Extraction: Addressing Health and Equity Concerns in Surface Mining Communities of Libjo, Dinagat Islands

*Policy pathways to address perceived health risks, service gaps, and inequities in mining-affected communities of Libjo, Dinagat Islands*


## KEY FINDINGS

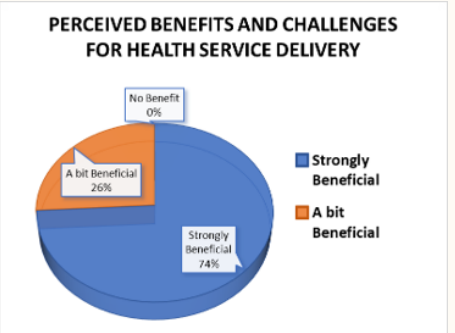
### *Perceived Impact based on Health Determinants*

- Improvements in income levels, employment, road networks, educational institutions, and women's empowerment were observed.
- No effect was perceived in electricity and drinking water, while an equal improvement and no effect perception was observed in sanitation.



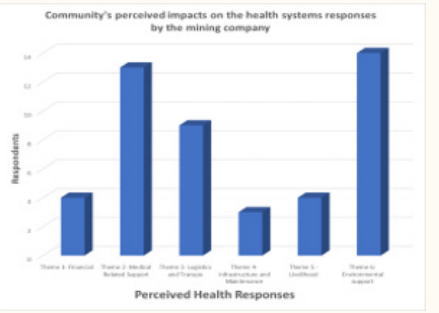

### *Perceived Impact based on the Level of Benefits*

- A majority of **74%** stated that the presence of mining company is **strongly beneficial** for health service delivery, while **26%** responded with a **bit beneficial** remarks.
- Interestingly, **none of the respondents (0%)** mentioned that the mining company had rendered no benefit in delivering health services in the community.




### *Perceived Impact based on Responses and Interventions by the Mining Company*

- The responses and interventions offered by the company, as perceived by the residents, can be categorized into six major themes: **financial support, medical-related support, logistics and transportation, infrastructure and maintenance, livelihood,** and **environmental support**.
- Medical and environmental-related supports were perceived to have the most impact in the community. This was followed by the logistics and transportation, financial, and livelihood.




### *Perceived Concerns by Community*

While the general outlook of the community leans towards positive impact, the community still perceived several negative concerns broadly categorized into the following: **air pollution**, **water pollution**, **deforestation**, **land degradation**, and **noise pollution**. Among these, air and water pollution are the most prevalently mentioned due to the presence of dust in the air and poor water quality in the area, particularly during peak hours of mining operations.

## POLICY RECOMMENDATIONS

- Conduct regular health checks, air, water, and noise monitoring, and health education in communities closest to mining sites, with mining companies working closely with local health units to address health risks in high-exposure areas.
- Implement transparent, equity-focused guidelines for the distribution of mining-related programs and benefits by conducting inclusive and participatory planning and implementation.
- Strengthen monitoring and mitigation measures by implementing effective dust suppression systems, water treatment facilities, and reforestation programs, with a focus on addressing air and water pollution during peak operational hours.
- Sustain efforts in logistics and transportation, financial assistance, livelihood programs, and infrastructure maintenance to ensure that community needs are effectively addressed and positive impacts are maximized.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# BUOD NGA PATAKARAN

## Labaw sa Pagmina:

## Pagtubag sa mga Kabalaka sa Panglawas ug Kaangayan sa Kumunidad sa Pang-ibabaw nga pagmina sa Libjo, Dinagat Islands

*Angay nga mga palisiya aron matubag ang gituohang mga risgo sa panglawas, kakulangan sa serbisyo, ug dili pagkapatas sa mga komunidad nga apektado sa pagmina sa Libjo, Dinagat Islands*

### Unsa ang kabalaka?

Ang pagmina importante para sa ekonomiya, apan nagpahinabo usab kini og polusyon, sama sa abog ug uban pang makadaot nga mga materyales, kon kini magkalot, magdugmok, mag-transport, ug magproseso sa mga mineral [1].

Ang mga komunidad sa pagmina ug ang kasikbit nga mga residente kanunay nga nag-antos sa mga problema sa kahimsog sama sa mga sakit sa respiratoryo, kanser sa baga, tuberculosis, pagkawala sa pandungog, ug kahimtang sa panit [2].

Kini nga mga problema tungod sa dili maayo nga kalidad sa hangin ug kontaminado nga tubig, nga mahimong mosangpot sa mubo ug dugay nga mga isyu sa panglawas alang sa tanan, bisan unsa pa ang edad o gender [3].

Ang Libjo, usa ka gamay nga lungsod sa baybayon nga nahimutang sa habagatang bahin sa Pilipinas, nagmina sa nickel sa usa ka dako nga sukod. Kadaghanan sa mga tawo sa Libjo nagtrabaho sa pagpanguma, pagpangisda, o pagmina. Tungod sa kahilit sa lokasyon sa lungsod, kasagaran nga mapasagdan ang mga panginahanglanon sa panglawas sa publiko, nga nagbutang sa katawhan sa risgo sa ilang kaayohan.

### PAMAAGI SA PAGSUSI

Ang Key Informant Interviews (KIIs) gihimo sa lima ka komunidad nga duol sa minahan sa nickel sa Libjo ug Tubajon. Sa kinatibuk-an, 55 ka partisipante nga naglangkob sa mga sektor ang miapil sa maong pagtuon, nga nag edad sa 21 hangtod 67 anyos ug nagpuyo sa maong mga kumunidad o empleyado sa minahan sulod sa dili muubos ug unom (6) ka bulan. Ang tumong mao ang pagsabot kung giunsa pag-ila sa mga tawo sa lain-laing mga tahas ang epekto sa panglawas sa pagmina.

## MGA IMPORTANTENG RESULTA

- Ang kalihokan sa pagmina kasagarang gilantaw nga WALAY negatibong epekto sa kinatibuk-ang kahimsog sa katawhan sa palibot nga komunidad.
- Ang kadaghanan sa mga gipangutana mitaho nga ang paghatud sa serbisyo sa panglawas sa kompanya sa pagmina sa nickel labi ka mapuslanon sa komunidad. Lakip sa maong serbisyo mao ang pagpaayo sa lokal nga sistema sa tubig, paghatag ug libre nga kasilyas, ug paghatag ug akses sa klinika sa kompanya alang sa mga miyembro sa komunidad.
- Ang mga residente nga mas duol sa dapit sa pagmina mas negatibo ang pagtan-aw sa epekto niini sa panglawas, nga nagpakita ug kalainan sa panglantaw sa risgo base sa lokasyon.
- Ang ubang mga miyembro sa komunidad nagtan-aw nga ang mga interbensyon sa panglawas nga gipatuman sa mga minahan dili patas ang pag-apod-apod sa nagkalain-laing mga lugar.
- Ang mga kalihokan sa pagmina, ilabina sa peak operation hours, negatibong makaapekto sa kalidad sa hangin sa komunidad, nga naghatag kabalaka sa kahimtang sa panglawas sa kalikupan.

*Kini nga panukiduki gihimo sa mga faculty-researchers sa College of Mathematics and Natural Sciences (CMNS), College of Engineering and Geosciences (CEGS), and College of Humanities and Social Sciences (CHaSS) of Caraga State University.*

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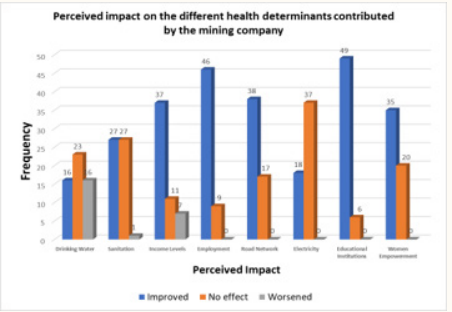
## MGA IMPORTANTENG NASUTA

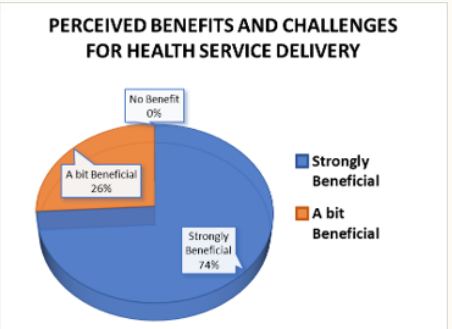
### *Gibati nga Epekto base sa Health Determinants*

- Ang mga pag-uswag sa lebel sa kita, panarbaho, mga network sa dalan, mga institusyon sa edukasyon, ug paghatag gahum sa kababayen-an naobserbahan.
- Walay epekto nga nakita sa elektrisidad ug tubig nga mainom, samtang usa ka patas nga pag-uswag ug walay epekto nga panglantaw ang nakita sa sanitasyon.



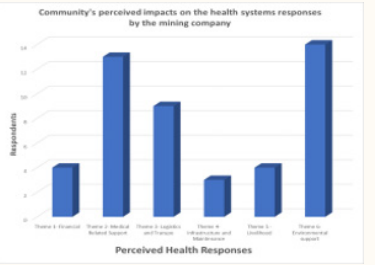

### *Gibati nga Epekto base sa Ang-ang sa mga Benepisyo*

- Kadaghanan sa **74%** nag-ingon nga ang presensya sa kompanya sa pagmina **labi ka mapuslanon** alang sa paghatud sa serbisyo sa kahimsog, samtang **26%** ang mitubag ug **gamay nga mapuslanon** nga mga pulong.
- Makapainteres, **walay bisan usa sa mga respondents (0%)** ang naghisgot nga ang kompanya sa pagmina **walay nahimo nga kaayohan** sa paghatud sa mga serbisyo sa kahimsog sa komunidad.




### *Gibati nga Epekto base sa mga Tubag ug Interbensyon sa Kompanya sa Pagmina*

- Ang mga tubag ug mga interbensyon nga gitanyag sa kompanya nga gitan-aw sa mga residente mahimong ma-categorize sa unom ka dagkong mga tema: **suportang pinansyal, suporta nga may kalabotan sa medikal, logistik ug transportasyon, imprastraktura ug pagpadayon, panginabuhi, ug suporta sa kinaiyahan.**
- Ang mga suporta nga may kalabotan sa medikal ug kalikopan gituohan nga adunay labing epekto sa komunidad. Gisundan kini sa logistik ug transportasyon, pinansyal, ug panginabuhi.




### *Gibati nga mga Kabalaka sa Komunidad*

Samtang ang kinatibuk-ang panan-aw sa komunidad nagsalig sa positibo nga epekto, ang komunidad nakasabut gihapon sa daghang negatibo nga mga kabalaka nga kaylap nga giklasipikar sa mga musunud: polusyon sa hangin, polusyon sa tubig, pagpuril sa kalasangan, pagkadaot sa yuta, ug polusyon sa kasaba. Lakip niini, ang polusyon sa hangin ug tubig mao ang labing kanunay nga gihisgutan tungod sa presensya sa abog sa hangin ug dili maayo nga kalidad sa tubig sa lugar, labi na sa peak hours sa mga operasyon sa pagmina.

### REKOMENDASYON SA PALISIYA

- Magpatuman og regular nga health check-up, pagmonitor sa hangin, tubig, ug kasaba, ug paghatag og edukasyon sa panglawas sa mga komunidad nga duol sa mga dapit sa pagmina, uban sa hapsay nga pakigtambayayong sa mga kompanya sa pagmina ug lokal nga health yunit aron matabangan ang komunidad nga duol sa Minahan.
- Ipatuman ang tin-aw ug patas nga mga giya sa pag-apod-apod sa mga programa ug benepisyo nga may kalabotan sa pagmina pinaagi sa inklusibo ug partisipatibong pagplano ug pagpanghimatuud.
- Palig-onon ang pagmonitor ug mga lakang sa pagpamenos sa kadaot pinaagi sa epektibong mga sistema sa pagkontrol sa abog, pasilidad sa pagtratar sa tubig, ug mga programa sa reforestation, nga magpasiugda sa pagsulbad sa polusyon sa hangin ug tubig ilabina sa mga oras sa peak operation.
- Padayon nga palig-onon ang paningkamot sa logistik ug transportasyon, pinansyal nga tabang, mga programa sa panginabuhi, ug pagmintinar sa imprastraktura aron masiguro nga epektibong matubag ang mga panginahanglan sa komunidad ug mapadako ang positibong epekto.

Mga Reperensya

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# Assessing Teachers' Practices and Cultural Factors for Culturally Relevant Comprehensive Sexuality Education in Grade 10 Science

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**ABSTRACT**

This study examines the practices of Grade 10 science teachers in relation to integrating Comprehensive Sexuality Education (CSE) into the science curriculum and also highlights key cultural considerations for culturally responsive classroom-based lesson exemplars. The study was conducted in Esperanza, Philippines, where twenty-one science teachers, across ten secondary schools, were studied in relation to four aspects of teaching conceptual formation, scientific skill acquisition, scientific value, and classroom instruction. The study additionally examined some critical cultural aspects, such as beliefs and values, language and terminology, religious and ethical issues, and gender and sexual orientation. The findings indicate that teachers are mostly favorable towards CSE integration; however, due to cultural sensitivity, there are challenges related to resource inadequacies and a need for professional development. Teachers realize the importance of cultural respect, the use of inclusive language, and engaging classroom discussions on sexual health. The study, therefore, affirms that there is a need for culturally relevant instructional materials for the purpose of tackling these challenges, with suggestions regarding improving teacher training and collaborative practices within the community. This research serves as a foundation for the development of culturally responsive and scientifically accurate CSE lesson exemplars, thereby guaranteeing inclusivity within Grade 10 science education.

Keywords: *Comprehensive Sexuality Education (CSE), Culturally Relevant Teaching, Cultural Considerations, Lesson Exemplars*

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## 1 Introduction

The integration of Comprehensive Sexuality Education (CSE) into the science curriculum has been increasingly recognized as a critical approach to equip students with accurate knowledge, positive values, and life skills that promote healthy sexual and reproductive behaviors (UNESCO 2018). CSE faces implementation challenges in various contexts, particularly in low- and middle-income countries. Teachers often experience conflicts due to cultural and religious sensitivities, leading to hesitancy in discussing sex education (Shibuya et al. 2023). The integration of CSE into educational systems is influenced by factors such as awareness of sexual health issues, availability of resources, and community perceptions (Chavula et al. 2022).

In the Philippine context, the Department of Education (DepEd) mandates the incorporation of CSE in subjects like science, focusing on developing students' understanding of the reproductive system, sexual health, and informed decision-making (DepEd Order No. 31, 2018). However, the implementation of reproductive health education remains controversial due to socio-cultural norms and religious beliefs (Kim et al. 2023). Teachers lack proper training and tend to minimize or modify their teaching due to fear of stimulating student interest in sex (Kim et al. 2023). The challenge of culturally relevant science teaching is evident, as demonstrated by a case study

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of the Obo Monuvu tribe, where teachers developed specific practices to address cultural competence and academic success (Pejaner & Mistades 2020). Similarly, Pasay-An et al. (2020) stressed the value of culturally contextualized sexuality education for indigenous youth in the Cordillera Region, and recommended inclusive, values-based sexuality education anchored in local traditions and beliefs. Also pertinent is a qualitative study by Bruno et al. (2024) that examined teachers' attitudes toward CSE, finding hesitancy and unease, which appeared to be a result of little training, parental pushback, and competing personal values. These findings highlight the need for contextualized and culturally sensitive approaches to CSE implementation.

This study, conducted in the municipality of Esperanza, Philippines, addresses these gaps by profiling the existing practices of Grade 10 science teachers in teaching science concepts integrated with CSE and by identifying key cultural considerations in the development of lesson exemplars. Specifically, this research focuses on four dimensions of teaching practices: concept formation, scientific skill acquisition, scientific attitudes, and classroom instruction. Furthermore, it examines cultural considerations essential for developing classroom-based sexuality education lesson exemplars, including cultural beliefs and values, language and terminology, religious and ethical considerations, and gender and sexual orientation.

By addressing these objectives, this research aims to provide valuable insights for educators and curriculum developers in creating instructional materials that are scientifically accurate and culturally relevant. The study's findings have the potential to contribute to the literature on culturally relevant teaching and CSE integration, offering a framework for designing instructional materials that are not only informative but also reflective of the cultural contexts in which students and teachers operate. Such an approach is crucial in ensuring that students receive comprehensive sexuality education that promotes informed decision-making, healthy lifestyles, and positive attitudes towards sexual and reproductive health.

## 2 MATERIALS AND METHODS

### *Research Design*

This study employed a descriptive research design to assess the current practices of Grade 10 science teachers in integrating Comprehensive Sexuality Education (CSE) into science concepts and to identify the cultural considerations relevant to the development of culturally relevant classroom-based sexuality education lesson exemplars. A descriptive design was considered suitable as it facilitates the methodical collection, analysis, and presentation of data that illustrate the status and attributes of the study variables. This approach offers a comprehensive overview of current teaching techniques and aspects to consider while creating culturally relevant instructional materials.

### *Population and Participants of the Study*

The research was carried out in the municipality of Esperanza, Philippines, focusing on all secondary schools in the region. The research participants were 21 science teachers presently instructing Grade 10 science across 10 secondary schools. Due to the limited population size, the study utilized a total enumeration sample method, guaranteeing that all teachers engaged in Grade 10 scientific education were incorporated as respondents. This methodology offered an extensive understanding of the educators' practices and viewpoints, enhancing the findings' representativeness and relevance to the study's specific context. The study's distribution and participants are shown in Table 1.

### *Research Instrument*

The research instrument utilized in this study was a researcher-made questionnaire specifically designed to gather data on the two research objectives. The questionnaire was structured into two sections. The first section aimed to determine the current practices of science teachers in integrating CSE into Grade 10 science concepts, focusing on four dimensions: concept formation, scientific skill acquisition, scientific attitudes, and classroom instruction. The second section sought to identify cultural considerations for developing culturally relevant sexuality education lesson exemplars, covering cultural beliefs and values, language and terminology, religious and ethical considerations, and gender and sexual orientation.

To ensure content validity and reliability, the questionnaire underwent expert validation by a panel specializing in science education, CSE integration, and culturally relevant pedagogy. Suggestions and recommendations from the experts were incorporated to refine the instrument and align it with the study’s objectives. In addition, the questionnaire was piloted with a small group of teachers (n = 30)

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**Table 1.** Distribution of the Participants of the Study

| Schools | Actual Science Teachers | Percentage (%) | Sex | | Age | | | |
|---|---|---|---|---|---|---|---|---|
| | | | Male | Female | 20-30 | 31-40 | 41-50 | 51 - 60 , up |
| Esperanza NHS | 7 | 33.33 | 2 | 5 | 1 | 3 | 2 | 1 |
| Catmonon NHS | 1 | 4.76 | - | 1 | - | 1 | - | - |
| Nato NHS | 2 | 9.52 | 1 | 1 | - | 2 | - | - |
| Duangan NHS | 2 | 9.52 | - | 2 | 1 | 1 | - | - |
| Guadalupe NHS | 3 | 14.31 | 1 | 2 | 2 | 1 | - | - |
| Salu NHS | 1 | 4.76 | - | 1 | - | 1 | - | - |
| Santa Fe NHS | 1 | 4.76 | 1 | - | 1 | - | - | - |
| Hawilian NHS | 2 | 9.52 | 1 | 1 | - | 2 | - | - |
| Oro NHS | 1 | 4.76 | - | 1 | 1 | - | - | - |
| San Toribio NHS | 1 | 4.76 | - | 1 | - | 1 | - | - |

*Legend: a complete enumeration sampling method, also known as universal sampling, was employed in the identification of participants. A total of 21 Science teachers are distributed across 10 secondary schools.*

who were not involved as participants in the larger study but had similar demographic characteristics. The purpose of the pilot was to assess the clarity, relevance, and internal consistency of the items. Participants were asked to identify confusing wording, unclear instructions, and items that were difficult to understand. Based on their feedback and suggestions, changes were made, such as rewording confusing items, changing formatting for clarity, and dropping redundant items, in an effort to increase the validity and reliability of the instrument prior to final administration.

### *Data Gathering Procedure*

The data collection process commenced after obtaining approval from the Department of Education and securing consent from the school heads of the participating secondary schools in the municipality of Esperanza. The validated questionnaires were then personally distributed by the researcher to the 21 Grade 10 science teachers. A brief orientation was conducted to inform the participants about the purpose of the study, the confidentiality of their responses, and their voluntary participation.

The respondents were given ample time to complete the questionnaire at their convenience. The researcher ensured accessibility during the data collection period to address any concerns or questions from the respondents. After the allotted time, the completed questionnaires were collected, and the responses were organized and encoded for data analysis.

### *Statistical Treatment*

Descriptive statistical methods were employed to examine and interpret the gathered data. The study largely calculated techniques to summarize comments regarding teachers' current practices in integrating Comprehensive Sexuality Education (CSE) and cultural factors in their instruction. The computed means elucidated the degree of consensus for each item, presenting a clear representation of the educators' practices and perspectives. The results were subsequently connected with the research objectives to underscore key findings that could guide the creation of culturally responsive classroom-based CSE lesson exemplars for Grade 10 Science.

### *Ethics Statement and Declaration*

An ethics clearance was not secured before the conduct of the study; however, the research study adhered to minimum ethical standards, including voluntary participation, anonymity, and the collection of signed Free, Prior, and Informed Consent forms, with all authors agreeing to these provisions prior to the manuscript's submission.

## 3 RESULTS AND DISCUSSION

### *Level of agreement of the current practices of teachers in teaching science concepts integrating CSE in terms of the following: Concept formations, Scientific Skill Acquisition, Scientific Attitudes, and Classroom instructions*

The results in Table 2 summarize how teachers now teach science as a part of sexuality instruction

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**Table 1.** Profile of teachers' current practices in teaching science concepts with integration of CSE in terms of concept formation

| Item | Mean | Response |
|---|---|---|
| 1. I integrate concepts related to sexual health and reproductive processes into my teaching of Living Things and Their Environment. | 4.24 | Agree |
| 2. I emphasize the connections between biological concepts and sexual health in my lessons. | 4.38 | Agree |
| 3. I use examples related to sexual health to illustrate biological concepts. | 4.41 | Agree |
| 4. I encourage students to explore the impact of biological concepts on sexual health in their projects or assignments. | 4.22 | Agree |
| 5. I provide opportunities for students to discuss cultural and societal influences on sexual health. | 4.19 | Agree |
| 6. I create a safe and inclusive environment for discussing sexual health topics in my classroom. | 4.46 | Agree |
| 7. I use a variety of teaching strategies to help students understand the relevance of sexual health to biology. | 4.51 | StronglyAgree |
| 8. I incorporate current research and developments in sexual health into my teaching of biological concepts. | 4.08 | Agree |
| 9. I emphasize the importance of understanding sexual health as part of a comprehensive understanding of biology. | 4.46 | Agree |
| 10. I encourage students to critically analyze the implications of biological concepts on sexual health. | 4.43 | Agree |
| **Average** | **4.34** | **Agree** |

***Mean: 1.00-1.49– Strongly Disagree, 1.50-2.49 – Disagree, 2.50-3.49 – Neutral, 3.50-4.49 – Agree, 4.50-5.00– Strongly Agree***

and how they form concepts. An overall mean score of 4.34 in the table, yielded within the range of 3.50-4.49 (Agree), indicates that the statements did not receive disagreement but, rather, received agreement from teachers. This clearly explains that teachers are ready to integrate ideas on reproductive processes and sexual health into their science lessons.

More specifically, item 7, "I use a variety of teaching strategies to help students understand the relevance of sexual health to biology," had the highest average score of 4.51, which assumed the meaning of Strongly Agree. This suggests a markedly positive commitment to employing a range of pedagogical approaches on the part of the teachers to make sure that students integrate sexuality education and biology. Interestingly, this supports recent research that emphasizes the importance of diverse and innovative teaching strategies in biology and sexual health education. Elkhidir (2020) highlights the shift towards student-centered learning in biology education, incorporating computer modeling, simulations, and problem-based learning to enhance critical thinking. Bhoi (2024) advocates for personalized learning, differentiated instruction, and interdisciplinary approaches to create engaging biology learning environments. Haruna et al. (2018) focus on sexual health education, noting the efficacy of game-based learning and gamification in developed countries for improving knowledge transformation, critical thinking, and motivation among students.

Nonetheless, while these encouraging self-report scores are promising, it is important to question whether those perceived practices are actually demonstrated in classroom instruction. Perceived practices do not equal real practice. Without classroom observations, student feedback, or some other form of data, it is unclear whether such strategies are actually employed and consistently effective in classrooms. Examining the extent of alignment between teachers' beliefs and teaching actions is important, even more so for culturally sensitive topics such as sexuality education, when teachers might experience internal or external obstruction from particular strategies—whether to use a certain strategy or whether to teach sexuality education altogether.

Correspondingly, Items 6 and 9, both emphasizing the importance of safe and inclusive environments for sexual health discussion within a broad-based understanding of biology, received high mean scores of 4.46. Thereby, they mean that the teachers recognize the need to create a safe environment within the classroom where students are comfortable discussing sexuality and health. This is linked to the work of Scholer (2002), which highlights the need to go beyond basic anatomy, advocating for a comprehensive approach that includes critical thinking and field-specific relevance. Walker et al. (2020) identifies key factors influencing the quality of sexual and reproductive health education, including teacher confidence, school policies, and prioritization of the subject. While these responses show positive attitudes, we need to consider how these beliefs are put into

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practice. These teachers could be proponents of inclusive and safe learning environments, and yet their practice may be eclipsed by a lack of training, their own discomfort, school culture, or opposition from parents. Therefore, the magnitude of the gap between perception and practice is a crucial component of ensuring that Comprehensive Sexuality Education (CSE) is both well-intentioned and intentionally practiced.

It's interesting to note that question 8, "I incorporate current research and developments in sexual health into my teaching of biological concepts," had a mean score of 4.08, which was somewhat lower. Therefore, teachers see this as an opportunity for improvement, especially because it lingers on the Agree range. Teachers must be aware of updated materials when applying research, but this is often blocked by restricted access or professional development opportunities on the subject. Research indicates that professional development (PD) and access to resources significantly impact teachers' ability to deliver comprehensive sexual health education. Studies show that PD is associated with increased coverage of sexual health topics and time devoted to teaching them (Clayton et al. 2017).

However, barriers such as teacher comfort, time constraints, and lack of training persist (Cummings et al. 2021). While some research supports the effectiveness of comprehensive sex education (CSE), critics argue that many studies cited as evidence for CSE do not meet scientific standards for program effectiveness (Ericksen & Weed 2023). To improve sexual health education, ongoing professional development is needed to broaden teachers' understanding of comprehensive approaches, address barriers, and strengthen educator capacity and self-efficacy. This highlights the importance of providing teachers with up-to-date resources and training opportunities in sexual health education.

In terms of scientific skill acquisition, the results in Table 3 shed light on how teachers are currently teaching science ideas while incorporating sexuality education.

In the context of sexuality education, teachers generally concur on integrating approaches that foster the cultivation of scientific competencies, as evidenced by an average mean score of 4.37. This indicates that, especially for topics relevant to sexual health, teachers consistently involve their students in

**Table 3.** Profile of the current practices of teachers in teaching science concepts integrating sexuality education in terms of Scientific Skill Acquisition

| Item | Mean | Response |
|---|---|---|
| 1. I promote inquiry-based learning methods to help students develop scientific skills related to sexual health. | 4.32 | Agree |
| 2. I provide opportunities for students to develop skills in data analysis and interpretation within the context of sexual health. | 4.27 | Agree |
| 3. I encourage students to use evidence-based reasoning when discussing topics related to sexual health in Living Things and Their Environment. | 4.35 | Agree |
| 4. I integrate opportunities for students to develop skills in scientific communication when discussing sexual health concepts. | 4.35 | Agree |
| 5. I use formative assessments to gauge students' understanding of scientific skills related to sexual health. | 4.32 | Agree |
| 6. I provide constructive feedback to students to help them improve their scientific skills in the context of sexual health. | 4.43 | Agree |
| 7. I incorporate hands-on activities that help students apply scientific skills to understand sexual health and reproductive processes. | 4.30 | Agree |
| 8. I encourage students to collaborate and communicate effectively when working on projects related to sexual health. | 4.49 | Agree |
| 9. I provide opportunities for students to engage in discussions and debates about scientific concepts related to sexual health.] | 4.32 | Agree |
| 10. I create learning experiences that allow students to explore their own interests and questions related to sexual health. | 4.54 | Strongly Agree |
| **Average** | **4.37** | **Agree** |

***Mean: 1.00-1.49– Strongly Disagree, 1.50-2.49 – Disagree, 2.50-3.49 – Neutral, 3.50-4.49 – Agree, 4.50-5.00– Strongly Agree***

activities that cultivate vital scientific competencies such as inquiry, data analysis, evidence-based reasoning, and scientific communication. Recent professional development initiatives, including the Comprehensive Sexuality Education (CSE) Training developed by the Department of Education (DepEd), in partnership with UNESCO and UNFPA, help teachers further develop these pedagogical skills. The DepEd-UNESCO CSE program, which started in 2018 and trialed in various regions, helps give teachers the skills needed to incorporate sexuality education into their Science, MAPEH, and Values Education subjects through a rights-based and gender-responsive perspective (UNESCO 2019). The Family Planning Organization of the Philippines (FPOP) also offers teacher training and peer educator training for youth-centered sexual and reproductive health education (FPOP 2020). This

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provides opportunities for educators to combine sex education with science-based thinking, making sure that lessons are based on evidence and are appropriate for the development of the majority of young people we teach.

The highest mean score was 4.54, which reveals Strongly Agree in Item 10, "I create learning experiences that let students explore their own interests and questions around sexual health." Educators are thus encouraged to engage with these kinds of student-directed sexuality education topics that land in the wheelhouses or zones of proximal development for students' personal interests and curiosities. Game-based learning and gamification have shown significant benefits in increasing student engagement, motivation, attitude, and knowledge compared to traditional teaching methods (Haruna et al. 2018, Haruna et al. 2019). The MAKE framework (Motivation, Attitude, Knowledge, and Engagement) has been validated as a comprehensive tool for evaluating the efficacy of these approaches (Haruna et al. 2019). In this study, teachers demonstrated classroom practices aligned with the MAKE components, such as motivational hooks, integration of values, fact-based teaching, and active learning for students. The framework also aligns with the Department of Education's lesson planning format, which emphasizes motivation, values, content mastery, and learner engagement. Long-term studies of sexual health education programs have shown increasing student support for the inclusion of social health topics, such as consent, in the curriculum (Kedzior et al. 2021). These findings suggest that student-centered, interest-driven approaches can significantly improve the effectiveness of sexual health education for adolescents.

The third and fourth items, promoting scientific communication skills (mean 4.35), overlap largely with advocacy of evidence-based reasoning. This indicates that in conversations on sexuality, educators should be focusing on or giving more attention to the development of critical thinking and communication skills, which is a central theme to being scientifically literate. In fact, teachers are already integrating these methods by working with students: debating structured topics on reproductive health, completing small group presentations involving the content of STIs and prevention strategies, and writing reflective essays on topics related to gender identity and respectful relationships. The results support the argument made by Cavagnetto (2010) that scientific education should focus on more than just delivering knowledge, especially in relation to sensitive and important topics such as sexual health.

The second highest mean score of 4.49 is item 8, "I encourage students to work together with effective communication as a project or initiative based on sexual health," which means that educators are developing strategies for the importance of group participation in science education. Teaching practices have been structured around Vygotsky's Social Constructivist Theory. Collaborative learning is central to modern science education standards, fostering conceptual understanding through interaction with more capable peers and cultural tools (Holley 2019). Engaging students in collaborative discourse and argumentation enhances their conceptual understanding and scientific reasoning abilities (Osborne 2010). These approaches collectively support the idea that science education should focus on more than just delivering knowledge, particularly for sensitive topics like sexual health.

Item number 2, "I provide students with opportunities to analyze and interpret data related to sexual health," received the lowest mean score that fell within the anonymous Agree range as well. This would imply that sexuality education should be chosen as a priority exercise and activity related to information. Božović (2023) and Gibson and Mourad (2018) argue that data literacy is a key requirement for understanding scientific claims, because students must be able to exercise judgment over the evidence they can encounter as medical information; misinformation in health contexts may have serious consequences.

The findings demonstrate that teachers are utilizing ways that successfully promote the development of scientific skills through the incorporation of sexuality education. Nonetheless, more opportunities should be provided to analyze and understand the data. Improving this component could aid students in making better educated decisions regarding their health and well-being based on true facts. Offering teachers professional development opportunities focused on data literacy in sexuality education could improve these techniques.

The results in Table 4 outline the profile of teachers' current practices in teaching science concepts integrated with sexuality education, focusing on fostering Scientific Attitudes among students. The overall average mean score of 4.56 means that teachers Strongly Agree with their

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**Table 4.** Profile of the current practices of teachers in teaching science concepts integrating sexuality education in terms of Scientific Attitudes

| Item | Mean | Response |
|---|---|---|
| 1. I create a supportive environment where students feel comfortable discussing topics related to sexual health. | 4.57 | Strongly Agree |
| 2. I encourage students to approach discussions about sexual health with an open and respectful attitude. | 4.57 | Strongly Agree |
| 3. I promote a positive attitude towards learning about sexual health and reproductive processes. | 4.59 | Strongly Agree |
| 4. I emphasize the importance of respecting diverse perspectives and experiences when discussing sexual health. | 4.68 | Strongly Agree |
| 5. I provide opportunities for students to reflect on their own attitudes and beliefs about sexual health. | 4.59 | Strongly Agree |
| 6. I address misconceptions and stereotypes related to sexual health in my teaching. | 4.54 | Strongly Agree |
| 7. I encourage students to consider ethical and moral implications of scientific concepts related to sexual health. | 4.51 | Strongly Agree |
| 8. I promote empathy and understanding towards individuals with different sexual orientations and gender identities. | 4.49 | Agree |
| 9. I use inclusive language and examples that reflect the diversity of experiences related to sexual health. | 4.46 | Agree |
| 10. I model positive attitudes and behaviors when discussing sensitive topics related to sexual health. | 4.62 | Strongly Agree |
| **Average** | **4.56** | **Agree** |

***Mean: 1.00-1.49– Strongly Disagree, 1.50-2.49 – Disagree, 2.50-3.49 – Neutral, 3.50-4.49 – Agree, 4.50-5.00– Strongly Agree***

attempts to promote positive scientific attitudes when they talk about sexual health and reproduction in the classroom. This finding shows that teachers are actively creating an atmosphere that promotes respect, acceptance, and an open mind, all of which are necessary for sexuality education to work. However, it is important to note that these results are based on the participants' self-perceptions and self-reported practices. Although self-perceptions are informative, they may not rise to the level of reality in the classroom. Therefore, additional levels of confirmation through classroom observations, lesson plans, or student-related information would be needed to confirm this evidence. For the study, it is important to note that classroom observations were not used; therefore, this limitation could be addressed through future research.

Items 1 and 2, pertaining to the establishment of a supportive environment and the promotion of openness and respect in talks, received high mean scores of 4.57. This points towards creating a comfortable and valued classroom environment where students feel free to talk openly about sensitive issues, cultivating positive attitudes and strong critical thinking skills in students. As for the respective theoretical grounds, Monteiro et al. (2021) posited that secure and accepting environments are necessary for profoundly engaging in sexuality discussions, thereby propelling scholars toward positive attitudes and robust critical thought development. The statement with the highest average score of 4.68 out of 5, "I emphasize the importance of respecting diverse perspectives and experiences when discussing sexual health.", prioritizes the idea that teachers tremendously aid in establishing an inclusive and tolerant environment within their schools, which is crucial for teaching sexuality education. Respect for varied opinions gives insight and concern in students for people belonging to varied national, social, and humane backgrounds, which matches Phillips et al. (2023) findings that respect for difference is an important component to avoid discrimination and rally the community.

Both item 3, "I encourage a positive attitude toward learning about sexual health and reproductive processes," and Item 5, "I provide chances for students to reflect on their own beliefs and attitudes regarding their sexual health," concluded with a mean of 4.59, upholding the right business of the teachers in establishing a positive and reflective environment for learning. Similar findings are derived by Biswakarma et al. (2024), who state that students are more likely to obtain positive rewards and knowledge on sensitive topics such as sexual health when they are asked to consider their attitudes and beliefs. There were high average scores in items 8 and 9, though they received slightly lower mean scores of 4.49 and 4.46, respectively. These refer to encouraging understanding and inclusive use of language. This means that, although the teachers encourage understanding and acceptance, they should have performed even better. This could also suggest that barriers may inhibit this from being achieved, such as an inability to use inclusive language or a lack of training regarding the handling of people from varying sexual orientations and gender identities. This goes hand in hand with what was noticed by Dewi (2024) and Fernández-Portero

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(2022), whereby it was noted that some teachers were insufficiently trained and therefore only felt less confident about using inclusive and gender-sensitive language.

The analysis indicates that teachers do promote science in a certain innovative dimension, that is, the incorporation of sexuality education within science instruction. Teachers' approaches should be optimized with even more exposure to inclusivity and empathy, including diverse cultural examples and language, with which an environment of inclusion and equity can be established, allowing students to have a full understanding of sexual health and reproduction.

A comprehensive analysis in Table 5 summarizes the teachers' current practices for teaching science concepts related to sexuality education, particularly around Classroom Discussions, with an overall mean score of 4.50, thus indicating "Strongly Agree." Such a conclusion implies that teachers must use a variety of discussion techniques to get students to grasp concepts of sexual health in a science class context.

Item 3 garnered the highest mean, exhibiting a score of 4.59 with the statement "In my classroom, I provide accurate information about sexual health and reproductive processes." This comes with a big note to a teacher that explicitly giving proper and reliable bits of information is a must when teaching, especially for difficult topics. There's a major importance in sexual education of correct information dissemination because misinformation or lack of knowledge could keep alive the root cause of some myths and stereotypes. This tally with the findings of Zamponi et al. (2024), placed great emphasis on the fact that teachers ought to be well trained to communicate correct and scientifically reliable materials on sexual health to avert misunderstanding and re-circulating misinformation on the subject.

Items 5 and 9 have both landed on an average mean of 4.54. It said, "I encourage students' engagement and participation when discussing sexual health topics in my classroom," and "I create a classroom environment that fosters collaboration and respectful dialogue about sexual health." These figures reflect that teachers are actively instilling in students a sense of participation while also creating a culture that respects learning in the classroom, both of which are very desirable for good class discussion. Discussions where students think critically and are more willing to voice their opinions can happen if they are encouraged to participate and are assured of safety. This also reiterates Lin et al. (2021), that interactive discussions not only build student self-confidence but also ensure the successful acquisition of knowledge in sexual education.

Item 6, "I give students opportunities to ask questions and know more information about sexual health concepts," with a notably high score of 4.57, depicts the teachers as highly supportive of a sort of inquiry-based learning technique for eliciting the natural interest of students. By clearing up their doubts and expressing their feelings, the students can

**Table 5.** Profile of the current practices of teachers in teaching science concepts integrating sexuality education in terms of Classroom discussions

| Item | Mean | Response |
|---|---|---|
| 1. I use a variety of instructional methods (e.g., lectures, discussions, group activities) to teach concepts related to sexual health in Living Things and Their Environment. | 4.41 | Agree |
| 2. I adapt my teaching strategies to meet the diverse learning needs of students when discussing sexual health. | 4.46 | Agree |
| 3. I provide clear and accurate information about sexual health and reproductive processes in my classroom instructions. | 4.59 | Strongly Agree |
| 4. I incorporate multimedia resources (e.g., videos, websites, guest speakers) to enhance students' understanding of sexual health concepts. | 4.46 | Agree |
| 5. I encourage student engagement and participation when discussing sexual health topics in my classroom. | 4.54 | Strongly Agree |
| 6. I provide opportunities for students to ask questions and seek clarification about sexual health concepts. | 4.57 | Strongly Agree |
| 7. I use assessments that allow students to demonstrate their understanding of sexual health concepts in different ways. | 4.46 | Agree |
| 8. I provide timely and constructive feedback on students' understanding of sexual health concepts. | 4.46 | Agree |
| 9. I create a classroom environment that fosters collaboration and respectful dialogue about sexual health. | 4.54 | Strongly Agree |
| 10. I use real-world examples and case studies to illustrate the relevance of sexual health to students' lives. | 4.49 | Agree |
| **Average** | **4.50** | **Agree** |

***Mean: 1.00-1.49– Strongly Disagree, 1.50-2.49 – Disagree, 2.50-3.49 – Neutral, 3.50-4.49 – Agree, 4.50-5.00– Strongly Agree***

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better understand and make the exercise worthwhile. Vilaça (2017) and Helbekkmo et al. (2021), revealed that having open conversations and allowing the students to ask questions is a sure method to ensure the students understand sexual health. It also helps to ease students into talking about these issues.

Although the scores for item 1 "I use a variety of instructional methods (e.g., lectures, discussions, group activities) to teach concepts related to sexual health in Living Things and Their Environment" and item 10 "I use real-world examples and case studies to illustrate how sexual health is relevant to students' lives" were a little less high, which indicates an Agree response (4.41 and 4.49), there is still some distance that can be covered yet in these two areas. Even if teachers do use a variety of teaching methods and models from real life– inquiry-based learning (IBL), problem-based learning (PBL), concept mapping, collaborative learning, reflective journaling, and values through learning, there is still potential for them to continue evolving in these areas. Such a combination would put more experience in the hands of students regarding learning and make the subject connect with them, thus making it more applicable to their lives. In sexuality education, Couto et al. (2023) state that using real-life situations, and a variety of teaching methods can help bridge the gap between theoretical knowledge and practical application, thus completing the learning circle.

The results clearly indicate that teachers generally lead discussions on sexuality education quite well within their science classes. Basically, this shows that the teachers are indeed making efforts to engage students, provide them with accurate information, and maintain respectful conversations. Hence, making the thoughtful dialogue slightly better with more teaching methods and real-life examples will enhance general discussions with students. Such improvements would make sexuality education even more practical, making students more thoughtful, analytical, and tolerant.

**The profile considerations for developing culturally responsive classroom-based sexuality education lesson exemplars for grade 10 science in terms of: Cultural beliefs and values, Language and Terminology, Religious and Ethical considerations, and Gender and Sexual Orientation**

The results in Table 6 show the profile considerations for developing culturally relevant classroom-based sexuality education lesson exemplars for Grade 10 Science in terms of Cultural Beliefs and Values.

The overall mean score is 4.52, which falls into the "Extremely Important" range. This indicates the jubilation of the highly inclusive presentation of cultural views and values during the development of these lessons. Along with item 6, "Address stereotypes and misconceptions about cultural groups in the materials," the average score was 4.62, indicating a sense of strong opinion among teachers that stereotypes needed to be addressed and dismantled so that educational materials would be less limiting and more culturally relevant. It affirms that when students break the stereotypes, it

**Table 6.** Profile considerations for developing culturally responsive classroom-based sexuality education lesson exemplars for grade 10 science in terms of Cultural beliefs and values

| Item | Mean | Response |
|---|---|---|
| 1. Consider the cultural beliefs and values of my students when developing materials related to sexual health. | 4.54 | Extremely Important |
| 2. Incorporate examples and scenarios in the materials that reflect the cultural diversity of my students. | 4.57 | Extremely Important |
| 3. Seek input from students, parents, and community members to ensure that the materials respect cultural beliefs and values. | 4.27 | Very Important |
| 4. Provide opportunities for students to discuss how cultural beliefs and values influence their understanding of sexual health. | 4.46 | Very Important |
| 5. Use culturally relevant language and imagery in the materials to make them more relatable to students. | 4.59 | Extremely Important |
| 6. Address stereotypes and misconceptions about cultural groups in the materials. | 4.62 | Extremely Important |
| 7. Provide resources and support for students who may have different cultural perspectives on sexual health. | 4.57 | Extremely Important |
| 8. Encourage students to share their cultural experiences and perspectives related to sexual health. | 4.57 | Extremely Important |
| 9. Collaborate with colleagues and community members to develop culturally responsive materials. | 4.46 | Extremely Important |
| 10. Regularly review and update the materials to ensure they remain culturally relevant and sensitive. | 4.57 | Extremely Important |
| **Average** | **4.52** | **Extremely Important** |

***Mean: 1.00-1.49– Not Important, 1.50-2.49 – Slightly Important, 2.50-3.49 – Moderately Important, 3.50-4.49 – Very Important, 4.50-5.00– Extremely Important***

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creates an atmosphere of respect and openness in the classroom, as pointed out by Ladson-Billings (2014). She also noted how culturally relevant pedagogy influences some aspects of equity and acceptance.

Items 2, 5, 7, 8, 9, and 10 received extremely important ratings on all the above counts, receiving mean scores of between 4.57 and 4.59. Some of these include using varied examples and scenarios, culturally appropriate language and images, supporting students with several perspectives, encouraging students to share their cultural experiences, collaboration with other teachers and community members, and regular reviews and updates of materials. The strong scores the teachers received in these areas are proof of their commitment as agents creating and ensuring that the content is not only inclusive of different ethnic types, but also considers that and maintains relevance to the students' lives.

Item number 3 states, "Get feedback from students, parents and community members to make sure that the materials respect cultural beliefs and values." The mean of this item is quite low at 4.27. While feedback is deemed important, it is less important than the rationale behind challenging stereotypes or using culturally-relevant language. The implication is that teachers do value input from the community, but participation in active stakeholder engagement may be tough for them. According to Ashrafova (2024) and Hatchimonji et al. (2017), it has also been difficult for communities to provide input into curriculum development because of time constraints and differing perspectives.

The results presented in the table indicate that these educators rank cultural considerations as number one in making tools for sexuality education. Educators seek to make learning more meaningful to all by confronting stereotypes, including culturally relevant materials, and giving students an opportunity to express their cultural views. Involvement in the community is deemed important; however, school-community collaboration may need much greater efforts to strengthen partnership in the development of culturally relevant lesson examples. The overall results indicate that educators are committed to developing materials that are culturally responsive and seek to cater to their students' varied cultural backgrounds, thereby contributing to a welcoming and supportive school climate for everyone.

The results shown in Table 7 are about profile things to think through when preparing sexually based lessons in Grade 10 that are culturally sensitive, particularly in terms of the language and terminology used. Its mean score is 4.69, which falls into the category of Extremely Important. This rather reinforces the importance of using vocabulary and terms that are broadly linguistic, communicable, and considerate of students' sexual identities and backgrounds.

This shows also that item 2 had the highest mean value (4.76): " Provide explanations and definitions for terms related to sexual health to ensure understanding." An important consideration for the teaching of sexual health concepts would be to clearly explain and provide understanding.

**Table 7.** Profile considerations for developing culturally responsive classroom-based sexuality education lesson exemplars for grade 10 science in terms of Cultural beliefs and values

| Item | Mean | Response |
|---|---|---|
| 1. Use language and terminology in the materials that are inclusive and respectful of diverse identities. | 4.70 | Extremely Important |
| 2. Provide explanations and definitions for terms related to sexual health to ensure understanding. | 4.76 | Extremely Important |
| 3. Avoid using jargon or technical language that may be confusing or alienating to students. | 4.70 | Extremely Important |
| 4. Use language that is gender-neutral and inclusive of different sexual orientations and gender identities. | 4.62 | Extremely Important |
| 5. Consider the linguistic diversity of my students and provide materials in multiple languages if necessary. | 4.62 | Extremely Important |
| 6. Provide opportunities for students to discuss and clarify any language or terminology used in the materials. | 4.65 | Extremely Important |
| 7. Use language that is age-appropriate and accessible to students at different levels of understanding. | 4.68 | Extremely Important |
| 8. Seek feedback from students and colleagues on the language and terminology used in the materials. | 4.73 | Extremely Important |
| 9. Use language that is empowering and affirming of students' identities and experiences. | 4.70 | Extremely Important |
| 10. Update the materials regularly to reflect changes in language and terminology related to sexual health. | 4.70 | Extremely Important |
| **Average** | **4.69** | **Extremely Important** |

***Mean: 1.00-1.49– Not Important, 1.50-2.49 – Slightly Important, 2.50-3.49 – Moderately Important, 3.50-4.49 – Very Important, 4.50-5.00– Extremely Important***

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It also emphasizes how important it would be to provide information without obscurity or confusion to any of the students. Bitzer (2024) indicated that information delivery should be clear enough and provide equitable health education access for students from all forms of their linguistic makeup.

Items 1, 3, 8, 9, and 10, garnering a score of 4.70, were also categorized as Extremely Important. These include using language that is respectful and inclusive of everyone, avoiding jargon and technical terms, asking for feedback on language use, using language supporting students' identities, and regularly updating materials to reflect changing language norms. The teachers got high ratings in these areas, suggesting that they were committed to creating a safe and supportive space for all students; according to Hernández and Darling-Hammond (2022), such a commitment underscores the role of affirmation language in positive identity development and stigma reduction. The scores given to statements 4, 5, and 6, while somewhat lower at 4.62 and 4.65, were also within the range of Extremely Important. This covers such matters as using gender-neutral language, being mindful of various languages, and allowing students to express the meaning of terms. Although these aspects might not be as towering as definition and feedback about individual words and phrases, they do signify the importance of accessibility and inclusivity altogether.

The results presented in the table indicate that the teachers carefully considered the language used in the culturally sensitive lesson exemplars. The teachers understand the importance of making language respectful, non-threatening, and easily understandable to allow all the students to feel respected and understood. Saito-Stehberger (2022) posits that the language used must relate to students' real-life situations to give communication and engagement in sexuality education a greater chance. Provided with all this, teachers are sensitive to language and terminology that have implications for student understanding and the level of engagement in learning. Their materials should connect with students across a vast range of backgrounds, be sensitive and inclusive, and make learning supportive and empowering.

In Table 8, Religious and Ethical Considerations form an essential portion of the profile considerations for developing culturally responsive, classroom-based sexuality education lesson exemplars for Grade 10 Science. The overall average mean score is 4.70, which indicates that they are all deemed Extremely Important. The acceptance and recognition of students' religions, as well as their moral beliefs, should be considered when covering sexuality education, and the material is expected to be culturally sensitive.

The questionnaire item that is most highly rated, with a mean score of 4.84, is, “Use language and examples in materials that are inclusive of different religious and ethical perspectives." This speaks about the importance of recognizing and honoring a student's uniqueness and background. This also means that teachers must adhere to becoming sensitive and welcoming, which has been, in this case, mostly emphasized by several principles propagated by the testimony of groups, among them UNESCO (2018), emphasizing the religious and moral diversities in sexuality education. Items 2 and 3 received mean scores of 4.78, which are statements that emphasize flexible instruction respecting various religious views and do not endorse any one doctrine. This observation shows that teachers are concerned with sexuality education, teaching it fairly and thus ensuring that it neither contradicts nor undermines students' religious or moral beliefs. This principle is also consistent with the principles of neutrality and inclusion advocated by Bialystok (2019). The study also adds that a sexuality education curriculum should help people learn without attempting to impose one's beliefs.

Item 4, " Provide opportunities for students to discuss how their religious beliefs influence their understanding of sexual health," got a score of 4.76. This reflects that room for talking and thinking about personal beliefs is taken to be of paramount importance for developing critical thinking and respect for different perspectives of big importance. Such discussions can develop mutual understanding and potentially avoid conflict rooted in different faith views (Sanjakdar, 2018; Phillips et al., 2023). Item 6: "Collaborate with religious leaders and community members to ensure that the materials are sensitive to religious beliefs" is rated a low 4.54, yet still clusters firmly in Extremely Important. This indicates an appreciation for working along with religious leaders but may not be assigned as much weight as some others, such as respecting views or ensuring information is unbiased. However, community involvement, as Bormet (2020) eloquently espouses, remains a vital aspect of facilitating culturally relevant tools.

The profound response demonstrates the

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**Table 8.** Profile considerations for developing culturally responsive classroom-based sexuality education lesson exemplars for grade 10 science in terms of Religious and Ethical considerations

| Item | Mean | Response |
|---|---|---|
| 1. Respect the religious beliefs and ethical considerations of students when developing materials related to sexual health. | 4.84 | Extremely Important |
| 2. Provide information about sexual health in a way that is respectful of different religious perspectives. | 4.78 | Extremely Important |
| 3. Avoid promoting or endorsing specific religious beliefs in the materials. | 4.78 | Extremely Important |
| 4. Provide opportunities for students to discuss how their religious beliefs influence their understanding of sexual health. | 4.76 | Extremely Important |
| 5. Address common questions and concerns related to sexual health from a variety of religious perspectives. | 4.68 | Extremely Important |
| 6. Collaborate with religious leaders and community members to ensure that the materials are sensitive to religious beliefs. | 4.54 | Extremely Important |
| 7. Provide resources and support for students who may have ethical or religious objections to certain topics or materials. | 4.62 | Extremely Important |
| 8. Use language and examples in materials that are inclusive of different religious and ethical perspectives. | 4.65 | Extremely Important |
| 9. Encourage students to explore the ethical dimensions of sexual health issues. | 4.68 | Extremely Important |
| 10. Regularly review and update the materials to ensure they remain respectful of religious and ethical considerations. | 4.70 | Extremely Important |
| **Average** | **4.70** | **Extremely Important** |

***Mean: 1.00-1.49– Not Important, 1.50-2.49 – Slightly Important, 2.50-3.49 – Moderately Important, 3.50-4.49 – Very Important, 4.50-5.00– Extremely Important***

importance teachers give to the inclusion of religious and moral issues in culturally sensitive sexuality education materials. In their school setting, they incorporated these considerations by consulting with religious and community leaders, aligning content with commonly accepted moral values, and carefully framing discussions to respect cultural beliefs while still providing accurate information. Some teachers also included scriptural reflections, used neutral or values-sensitive language, and emphasized respect, responsibility, and the ethical implications of decision-making in sexual health topics. This approach seeks to create a classroom in which all learners will feel welcomed, and their religious beliefs and values will be appreciated, culminating in higher engagement and understanding. By engaging in such, teachers facilitate understanding of co-existence, a diversity which furthers the general health and happiness of the learners.

Table 9 depicts the profile considerations for the development of culturally responsive classroom-based sexuality education lesson exemplars for Grade 10 Science in terms of Gender and Sexual Orientation. The average mean scores across the items are 4.60, suggesting that all considerations are seen as Extremely Important. This language sets the tone for inclusivity in the battle for the right to articulate inclusive perspectives of sexual health underpinned by respect for various gender and sexual identities.

Item number 2 had the highest mean score of 4.70, "Provide sexual health information relevant to all students of all genders and sexual orientations," indicating the most attention should be given to ensure inclusion within the content. This implies that teachers ought to create a space where all students feel included and supported. This is consistent with results on inclusive education by Meadows (2018), which reinforce that inclusivity promotes engagement while reducing anxiety. Items 1 and 5 dealt with words and examples that include people from different sexual orientations and gender identities as well as correcting gender stereotypes and erroneous beliefs, scored 4.62 and 4.76, respectively. According to Brant and Tyson (2015), this is evidence that teachers are committed toward eliminating bias and encouraging a positive attitude toward difference, which is important for combating anti-minority sentiment and rendering a sense of belonging to all students.

While item 4, "Provide resources and support for students who may be exploring their gender identity or sexual orientation," earned a score of 4.57, this indicates that recognizing that understanding oneself is of paramount importance. From this, one can conclude that educators must create safe spaces for honest self-exploration. Shattuck et al. (2021) note that this sort of support is very much needed for students' mental health and perseverance, specifically for those who feel that they do not belong. Although item 9 received the lowest score of 4.30, a low score does not mean a poor investigation, but it does show progress on the part of the school. Though it is ranked as less

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**Table 9.** Profile considerations for developing culturally responsive classroom-based sexuality education lesson exemplars for grade 10 science in terms of Gender and Sexual Orientation

| Item | Mean | Response |
|---|---|---|
| 1. Use language and examples in the materials that are inclusive of different gender identities and sexual orientations. | 4.62 | Extremely Important |
| 2. Provide information about sexual health that is relevant to students of all gender identities and sexual orientations. | 4.70 | Extremely Important |
| 3. Avoid assumptions about students' gender identities and sexual orientations in the materials. | 4.54 | Extremely Important |
| 4. Provide resources and support for students who may be exploring their gender identity or sexual orientation. | 4.57 | Extremely Important |
| 5. Address stereotypes and misconceptions about gender and sexual orientation in the materials. | 4.76 | Extremely Important |
| 6. Use examples and stories that reflect the experiences of individuals with diverse gender identities and sexual orientations. | 4.62 | Extremely Important |
| 7. Provide opportunities for students to discuss and ask questions about gender and sexual orientation in a safe and respectful environment. | 4.68 | Extremely Important |
| 8. Use language that is affirming and respectful of diverse gender identities and sexual orientations. | 4.65 | Extremely Important |
| 9. Collaborate with LGBTQ+ organizations and community members to ensure that the materials are inclusive and supportive. | 4.30 | Very Important |
| 10. Regularly review and update the materials to ensure they remain sensitive to issues of gender and sexual orientation. | 4.57 | Extremely Important |
| **Average** | **4.60** | **Extremely Important** |

***Mean: 1.00-1.49– Not Important, 1.50-2.49 – Slightly Important, 2.50-3.49 – Moderately Important, 3.50-4.49 – Very Important, 4.50-5.00– Extremely Important***

important, it emphasizes the need for community involvement in updating materials that are sensitive to diversity in culture, such as Whaley et al. (2016) descriptions of a culturally relevant approach to selecting introductory psychology textbooks.

The high scores on all items indicate that teachers consider gender and sexual orientation with much contemplation when preparing culturally sensitive materials for sexuality education. In practice, they included students of every gender and sexual orientation, incorporated gender-neutral language, appealed to families in a variety of structures, and did not assume that students were heteronormative when using examples and scenarios in their teaching. Some teachers included stories or case studies that focused on the lived experience of LGBTQ+ individuals, executed thematic discussions during classes that emphasized respect and empathy regarding gender identity and expression, and focused on discrimination, and bullying. Others worked with guidance counselors to make sure the subject matter fit with their values of inclusivity, equity, and dignity for all, and that it was appropriate for the developmental stage of their students. The lessons are open to everyone to ensure that students feel respected and appreciated, allowing for varying points of view within the classroom. The findings have highlighted the need for awareness of gender and sexual orientation in sex education for it to be a welcoming and supportive environment for all students. By doing so, teachers enable students to engage with each other at deeper levels by fostering mutual respect for diversity and thereby promote the overall health and wellbeing of their students.

## 4 Conclusions and Recommendations

The present findings suggest that teachers engaged in this study generally support and endorse the inclusion of sexuality education within science lessons. In response to these topics, teachers report drawing on multiple teaching strategies to link topics of sexual health to biological content, thereby indicating a willingness to and following through with teaching reproductive processes and sexual health from a scientific perspective. It is evident that teachers encourage inquiry, data management, and critical thinking while establishing safe, inclusive spaces to discuss sensitive topics. It is also clear, however, that there is room for improvement in consistently using inclusive language and engaging in more detailed discussions regarding diverse gender identities and sexual orientations in schools. While teachers emphasize respectful discussion, accurate information, and student voice, they also recognize that if they were able to enhance their teaching by drawing on experiences and examples from life and models more embedded in specific cultures, the relevance and attention of students could improve. Cultural values and beliefs are part of their knowledge of dynamics in a classroom, and they also recognize the value that is placed on

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culturally responsive content. However, teachers recognize that engaging communities, particularly about the validation of materials and cultural applications, is a particular challenge.

To enhance these efforts, schools and education authorities should provide ongoing and comprehensive PD to fully develop teachers' confidence and capacity to address sexuality education in a biology context in interactive and experiential ways, such as through case-based learning, simulations, and role-play. Accessible knowledge for teachers and the development of resources, including teacher guides or resource packs that provide current knowledge and examples that are culturally relevant, can help support implementation in their classrooms.

There is also a need to co-create instructional materials in partnership with community stakeholders such as parents, health professionals, faith-based and cultural leaders, and youth advocates. This partnership can help to ensure that the materials are cultivated respectfully and inclusively in consideration of local belief systems. Collaboration strategies could involve consultations with families, focus groups, and feedback processes to foster trust, inclusion, and transparency in how items are accepted. Such collaborative forms of practice may help to challenge stereotypes, enhance conversations, and lead to a learning environment that celebrates all students with learning opportunities, while also improving the quality and cultural competencies of sexuality education in science.

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## 6 Statement of Conflict of Interest

The researchers declare that there is no conflict of interest regarding the publication of this paper.

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# Income Tax Rates (TRAIN Law) Level of Understanding and the Spending Preferences of Millennial Employees in Caraga State University

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**ABSTRACT**

The study determined the effects of the change in income tax rates brought by the TRAIN law on the millennial employees of Caraga State University. Specifically, this study determined the level of awareness of the employees regarding the income tax policy amendments, their spending preference where increased take-home pay is appropriated, and the relationship between the two variables. The study used a descriptive-correlational research design to determine the level of awareness, spending preference rank, and the relationship between the variables. Among the income tax provisions indicators, only tax exemption provisions were interpreted as moderately understood. On the other hand, the top-ranked expenditures are food, clothing, and medicines. The test for the relationship among the variables failed to reject the null hypothesis. Based on the descriptive results, the study recommends mainstreaming financial and taxation literacy seminars among millennial employees.

Keywords: *TRAIN law, income tax rates awareness, increased take-home pay, spending preference, millennial employees*

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## 1 Introduction

### *Background of the Study*

Bureaucratic processes are inherent and significant to societal structures. These different systems home individuals that contribute to the total structural and organizational functioning. Among these processes are the policy amendments that affect workers within the institution. In the Philippine context, the Republic Act 8424, also known as the Tax Reform Act or the National Internal Revenue Code (NIRC), was amended by Former President Rodrigo R. Duterte based on the Comprehensive Tax Reform Program. The first package of the law was implemented in January 2018, covered in Republic Act No. 10963 or the Tax Reform for Acceleration and Inclusion Law (Department of Finance – National Tax Research Center, 2018). The law provides new graduated income tax rates, which exempt the low-income earners from the tax burden, therefore increasing their take-home pay and purchasing power.

The need for studying income tax promulgations emphasized the role of the individual as a worker and a consumer. Understanding the influences on income change determines one's ability to adapt to economic fluctuations. In the Philippines, families have an average annual income of approximately two hundred sixty-seven thousand pesos (P267, 000.00), while their average annual expenditure is two hundred fifteen thousand pesos (P215, 000.00) (Philippine Statistics Authority, 2017). The law changed the Philippine economic and political system. This influenced various institutions, including Higher Education Institutions (HEIs), emphasizing the importance of the inquiry. Caraga

State University is one of the HEIs located in the Caraga region. The University houses 506 teaching and nonteaching employees who served as the main respondents of the study. Another key variable in understanding income and spending is by looking at different generation cohorts. In 2050, millennials or generation Y (1981-2000) will comprise 50 percent of the world's population of consumers. This piques the question of determining the spending capacity of millennials contemporarily. This group can be used as a baseline for future studies in comparing generational cohorts.

The study particularly inquired about the different levels of income, take-home pay, spending preferences of the CSU millennial employees, and their level of understanding of the income tax provisions of the TRAIN law. The end purpose of the study is to come up with recommendations to the Human Resource and Management Office (HRMO) for possible financial literacy intervention programs for the employees of Caraga State University (CSU).

***Theory***

The study used a combination of two (2) theories, namely the need theory and the permanent income theory by Friedman (1957). The need theory presents the psychological dimension of the individual, which states that an increase in income and wealth will lead to an increase in subjective well-being. This theory is based on the hierarchy of needs by Maslow (1943). The theory was connected to its significance to people's income and how disparities in income influence satisfaction levels and various needs. The consumers' desire and ability to buffer income shocks will determine the extent to which they will smooth fluctuations in consumption relative to income. On the other hand, the permanent income theory presents the economic dimension, which posits that the greater the income, the greater the purchasing power. Theory also emphasized that consumers behave as if their budget must be met on a period-by-period basis, but on a lifetime basis. The theory implies that the changes in consumer behavior are not predictable. This behavior is based on the individual's expectations. Thus, the Income and Need theory proposes that an increase in income and wealth leads to accessing needs that, in turn, leads to an increase in well-being. This is because money is utilized to satisfy basic psychological needs (Howell et al. 2012, p. 6).

In the study context, the study only applied the income increase and purchasing power variables, or the ability to meet needs. This means that this study did not measure the effects of income on subjective well-being, but instead only on accessing commodities. However, the well-being as a concept will still be used to support discussion on the needs theory in the rank expenditure data. The income increase is assessed through their level of understanding of the change in income tax rates, while the purchasing power or ability to meet their needs is measured through their ranked spending preference. Further, the generation cohort (Generation Y or Millennials) theory supplemented the prior theories in setting the study group. The cohort recognized the interplay between the individual and the environment. This further materialized their collective consciousness given the thriving disparities in the set strata of the study. With the millennials constituting more than half of the university employees' population, it is imperative to evaluate the economic and bureaucratic interplay between them and their institution.

## 2 Conceptual Framework

The framework's variables are as follows: TRAIN Law, Demographic profile, spending preference, and the program recommendation for CSU-HRMO.

The framework presented a directional relationship among the variables. The first variable is the level of understanding of income tax provisions, with an arrow-headed line pointing to the spending preference, connoting a relationship tested for significance. Between these two variables is the demographic profile set as the intervening variable. The final variable is presented with a bold arrow connoting the output of the study, namely the program recommendations to the CSU-HRMO. The theory application is also indicated in the relationship assessed in the study. As mentioned above, the permanent income needs theory determines the capacity of the consumer to respond to economic fluctuations. This posits that the higher the income, the higher the purchasing power, which could be determined based on the level of income. This is represented by the intention of the policy (TRAIN Law) to increase the take-home pay of the workers by reducing their income tax. On the other hand, the need theory emphasizes that needs are met when there is a permanent income. This is represented by the ranked spending preference of the study respondents. Specifically, the study hypothesizes

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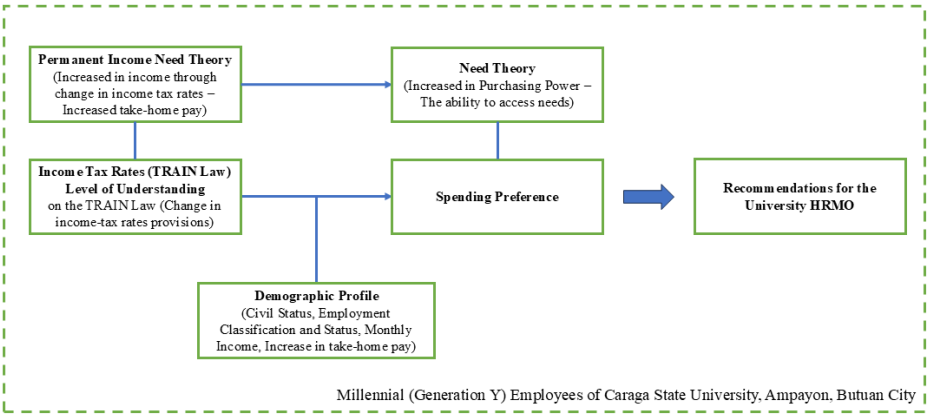


**Figure 1.** Research Paradigm

that the understanding of income tax amendment provisions influences the spending preference of the millennials, ceteris paribus (Need).

**Research Objectives**

The study determined the influence of change in income tax rates (TRAIN Law) through the level of understanding of the policy provisions and its effects on the spending preference of the millennial employees.

1. To determine the demographic profile of the respondents in terms of the following:
   a. civil status;
   b. employment classification;
   c. employment status;
   d. range of monthly income; and
   e. range of the increase in take-home pay

2. To determine the level of understanding of the millennial employees to the provisions of the TRAIN law?

3. To rank the spending preference of millennials from the increase in take-home pay, considering the following:
   a. food;
   b. clothing;
   c. household bills;
   d. medicines and other health expenses;
   e. educational expenses;
   f. entertainment and other recreational activities;
   g. payment of loans and borrowings;
   h. savings;
   i. investment; and
   j. insurance

***Hypothesis***

This study is guided by one (1) hypothesis, tested at a 0.05 level of significance.

$\mathbf{H_{A1}}$. There is a significant relationship between the level of understanding of change in income tax rates (TRAIN Law) and the spending preferences of the millennial employees

**3 Materials and Methods**

This section includes a discussion on research design, research environment, sampling technique, ethical considerations, data gathering procedure, and statistical treatment.

**Research Design**

This study utilized a descriptive-correlational research design, which is based on its appropriateness to the study objectives and allowed the researcher to employ descriptive statistics tools and test relationships among the variables.

**Sampling Technique**

The study utilized two formulas for sample derivation; the first was getting the sample size with the unknown population, and the second was equating the number of samples with a known population based on the first formula.

$$n = \frac{Z^2 p(1-p)}{E^2}$$

Formula 1: Determining sample size with an unknown population

Where:

Z = Z-score (based on confidence level, e.g., 1.96 for 95% confidence) $\rho$

p = Estimated proportion of the population
E = Margin of error

$$n = \frac{NZ^2p(1-p)}{E^2(N-1)+Z^2p(1-p)}$$

Formula 2: Determining sample size with an unknown population
N = Population Size
Z = Z-score (based on confidence level, e.g., 1.96 for 95% confidence) $\rho$
p = Estimated proportion of the population
E = Margin of error

The university employs a total of 506 employees, whose work spans from administrative to teaching. There are 210 permanent workers and 296 nonpermanent workers. Among the 210 permanent workers, 45 were on non-teaching jobs, while the remaining 165 were working as faculty. On the other hand, 174 of the 296 nonpermanent employees were working as administrative staff, while the remaining 122 were working as faculty. Out of the 506 employees, there are 293 millennials; this was set as the study population.

The study utilized stratified sampling technique. From the set number of samples, the strata were specified. Specifically, these include permanent teaching personnel, nonpermanent teaching personnel, permanent administrative workers, and nonpermanent administrative workers. For each stratum, the total number of workers was specified, and the required number of samples was distributed based on the appropriate number for representation by using proportionate probability sampling (PPS).

### *Ethical Statement and Declaration*

The study assessed and followed all the measures to conform to the ethical principles of research. In terms of beneficence and non-maleficence, the respondent's participation was based on their willingness. The respondents were oriented about the rationale and the intended output of the study. The researcher also emphasized the importance of non-disclosure of personal information, guided by the ethical principles of not providing incorrect, inadequate, and misguided information to reach the desired outcome of the research, and at the expense of the respondents. Possible risks were also discussed and included in the introductory clause of the instrument. In terms of the validity and reliability of the tool and data, validation was conducted by experts in the field and a study statistician.

An ethics clearance was not secured prior to the conduct of the study, however, the research study adhered to minimum ethical standards, including voluntary participation, anonymity, and the collection of signed Free, Prior, and Informed Consent forms, with all authors agreeing to these provisions prior to the manuscript's submission.

### *Data Gathering Procedure*

The data gathering procedure was undertaken through the following steps: (1) In conformance to Data Privacy Act (RA No. 10173), the researcher filled up the Freedom of Information (FOI) request form to access data, (2) after data retrieval, names were randomized following simple random sampling technique, (3) the names were stratified based on employment status and classification. This served as the basis for visiting offices for data gathering.

The data gathering process was undertaken through the following steps: (1) discussion of the rationale and ethical considerations, and (2) questionnaires were provided after approval. Refusal to participate will result in the succeeding name being placed in the list.

### *Statistical Treatment*

The gathered data, dependent on the statement of the problem, were analyzed and interpreted by the following methods. Most of the data are categorical, which failed to satisfy the assumptions

**Table 1.** Sample size distribution

| Employment Status | Employment Classification | Population | Sample Size |
|---|---|---|---|
| Permanent | Teaching | 165 | 32 |
| | Non-teaching | 45 | 9 |
| | **Subtotal** | **210** | **41** |
| Nonpermanent | Teaching | 122 | 43 |
| | Non-teaching | 174 | 69 |
| | **Subtotal** | **296** | **112** |
| | **Total** | **506** | **153** |

***Legend:*** *N=506, Millennial N=293, n=153*

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**Table 2.** Descriptive Interpretation

| Scale Ranges | Descriptive Interpretation | Defintion |
|---|---|---|
| 1.0-1.80 | No understanding | The respondent has no knowledge or awareness of the provision. This may include, but not be limited to, basic taxation terms, i.e., taxable income, exemption, tax rates, filing, etc. |
| 1.81-2.60 | Slightly understood | The respondent has minimal awareness of the tax provisions. The respondent may be able to recognize terms but may be unable to explain or apply them. |
| 2.61-3.40 | Somewhat understood | The respondent has a basic and partial understanding of income tax provisions. The respondent may be able to explain and apply them, but lacks depth. |
| 3.41-4.20 | Moderately understood | The respondent has a fairly clear grasp of the provisions and can explain and apply most of the key concepts correctly. |
| 4.21-5.0 | Fully understood. | The respondent shows a strong and accurate understanding of the provision and including technical aspects. The respondents can apply the policy provision correctly in real-life situations. |

for normally distributed data. This means that the study has utilized a nonparametric statistical test. (1) Frequency and percentages were used to present the demographic profile of the respondents. (2) The weighted mean was utilized in presenting the data. The last method used was (3) Spearman's test for correlation, which would determine the relationship between the understanding of TRAIN law and their spending preferences.

The second statement of the problem was analyzed through scales. The scale ranges are as follows: (See Table 2)

The indicated definitions for each of the descriptive interpretations generally cover the astuteness of the respondent to the specific provisions of the change in income tax policy. This generally varies on the understanding and awareness about taxation terminologies, the capacity to explain and apply concepts, understanding its technical aspects, and applying it in real-life situations.

Further, the elaborate meaning of the remarks are as follows: Fully understood means the respondents have complete knowledge of the provision, have encountered, practiced, and are astute to its process; moderately understood means that the respondent is aware of the provision, have encountered, and experienced but not fully astute to the related processes; somewhat understood means that the respondent is aware of the provision, have encountered, experienced its processes; slightly understood means the respondents have encountered and experienced the provision but not akin to the process, and no understanding means the respondent knows the provision but have no idea about its processes.

The third statement of the problem, on the other hand, was analyzed based on the ranking. The procedure was referred to as the forced rank scale undertaken through the forced ranked questions. The ranked expenditures were arranged based on their sequence of presentation. Inversely, the first expenditure on the list was multiplied by ten (10), as the list increased, the multiplier decreased. The highest product served as the top-ranking expenditure and was followed by the second least to the least expenditure.

For the hypothesis testing, this was tested with a significant level of P-value less than 0.05, which is commonly used in social science. The test and analysis in the study utilized the Statistical Package for Social Science (SPSS). The researcher also consulted with the statistician, who validated and aided the findings of the study.

## 4 Results and Discussions

This section discusses and presents the findings of the study. This includes presentations on the respondent's demographic profile, level of understanding of the income tax provisions of the TRAIN law, and their spending preferences. This also covers the analysis of data that determines the significance of the variables tested.

### *Demographic Profile*

Table 3 presents the demographic profile of the respondents. This shows the percentage and frequencies of the civil status, employment classification, employment status, income level, and take-home pay increase.

The specified income is already far beyond the current poverty threshold in the Philippines. According to PSA (2019), a family of five (5) would need a P10,481 income average to meet the household's basic food and non-food needs in a month. Concerning millennial earning income, a study comparing millennial spending preferences with other cohorts states that compared with the other employed generations, millennials have the lowest levels of income before taxes and the lowest

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**Table 3.** Demographic Profile of the Respondents

| | Indicators | Population | Sample Size |
|---|---|---|---|
| **Civil Status** | Single | 114 | 74.50 |
| | Married | 39 | 25.50 |
| | **Total** | **153** | **100** |
| **Employment Classification** | Teaching | 75 | 49.02 |
| | Nonteaching | 78 | 50.98 |
| | **Total** | **153** | **100** |
| **Employment Status** | Permanent | 41 | 26.80 |
| | Nonpermanent | 112 | 74.20 |
| | **Total** | **153** | **100** |
| **Income Range** | P18,000 and below | 59 | 38.60 |
| | P18,001 – P20,000 | 3 | 2.00 |
| | P20,001 – P22,000 | 3 | 2.00 |
| | P22,001 – P24,000 | 19 | 12.40 |
| | P24,001 – P26,000 | 7 | 4.60 |
| | P26,000 above | 62 | 40.50 |
| | **Total** | **153** | **100** |
| **Take-home Increase** | P1,000 and below | 34 | 22.22 |
| | P1,001 – P2,000 | 44 | 28.76 |
| | P2,001 – P3,000 | 63 | 41.18 |
| | P3,001 – P4,000 | 10 | 6.54 |
| | P4,001 – P5,000 | 2 | 1.31 |
| | **Total** | **153** | **100** |

average annual expenditures. This highlights the influence the income level of millennials has on their spending preference. Common ranges among the employees cover the salary grades 7-1 to 15-1. This was used as the basis of the income range presented in the study (See Appendix, Table 8). In the Family Income and Expenditure Survey (FIES) conducted in 2017, representing the year 2015, the average annual income of the Filipino family would be P189,000 and the average annual family expenditure would be P152,000 compared to 2012, the average annual income was P180,000 and the average annual family expenditure was P148,000 (PSA, 2017). The data present that there has been an increase in income in the succeeding years, which would direct consumers with their purchasing power and their spending preference (See Appendix, Figure 2).

In terms of the take-home increase brought by the TRAIN law to the millennial employees, there are five (5) ranges of income increase set in the study. Similar to the ranges set in income, which were based on the income schedule of the university employees, the take-home pay ranges were also fixed closely to those ranges. This also provided an efficient income and take-home increase presentation. These changes were directly a product of the change in the Tax schedule stipulated in the TRAIN law. In a message given by Briones (2018), the "Tax Reform for Acceleration and Inclusion" covers the policy objectives of TRAIN. The "inclusion" part refers to affording most of our income earners with tax relief through the new income tax schedule. Imposing a zero tax rate for taxable income up to P250,000.00 per year immediately benefits 83% of income taxpayers in the country. Recovery from the revenue loss due to the exemption, lesser tax liabilities, and an increase in net revenue, emphasize "acceleration."

These data imply that during this period, most of the millennial age range is on the entry level of employment, which explains the income level and working status. The increase in take-home pay is supported by the aforementioned literature, which suggests that policy amendments aim to improve accessibility to commodities for middle-class workers. This is reflected in the increased take-home pay among the workers. Further, the literature also supports that the compensation income earners

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(CIE) are moving farther from the poverty threshold, given the increasing annual average income, annual average expenditure, and the additional funding from increased take-home pay for their discretionary spending or savings. This also classifies the workers within the different hierarchies of middle-class income earners as classified by the FIES of PSA (PSA, 2017). This descriptive result aligns with the income need theory, as it stipulates that the greater the income, the greater the purchasing power. Given the additional take-home pay, consumers can have the desire and ability to buffer income shocks and maintain their spending on their needs. These needs will further be discussed regarding the ranked, prioritized expenditures of millennial employees.

***a. Level of understanding of the millennial employees on the change in income tax rates (TRAIN Law)***

This section discusses the level of understanding of the millennial employees to the provisions of the TRAIN law, which was enacted in 2018. In the report provided by the Department of Finance (2018), mentioned that to further capacitate the nation and achieve the needed funds, the following means were determined; tax policy reform to create a fairer, simpler, and more efficient tax system manifesting in low rates and a broad base that can promote job creation, investment, and poverty reduction; Tax administration reforms that cover BIR and BOC; and budget reforms to improve pace, efficiency, and transparency of spending. These highlighted goals that impinged its implementation. There are multitudes of aspects the TRAIN law covers, but this study solely focuses on the income earnings, tax derivations, exemptions, and benefits indicated in Table 4.

The mean result (3.25) for provision 1 covers the respondents' understanding of the change in income tax liability derivation, which is interpreted as somewhat understood. Income tax liability derivation is the process of determining the tax liability of employees from the gross income received. In the National Internal Revenue Code (1997), it is derived based on deducting the individuals' allowable exemptions from their annual income before determining which bracket their taxable income is in the ranges of the tax schedule to determine their tax liability. This tax liability is generally based on the tax schedule present in the tax form.

This leads to the mean result (2.98) of the level of understanding of employees to provision 2 stipulated in the study. The tax schedule or tax table is a set of brackets that stipulates the income of a citizen of a country and the corresponding amount of tax liability. With the implementation of the TRAIN law, these brackets were changed and updated. In 2018, DOF reported that they are redesigning the tax system and the goal is to correct the tax system's problems to become simpler, fairer, and more efficient. The system will lessen the overall tax burden on the poor and middle class (Department of Finance, 2018, p. 10). According to the Department of Finance – National Tax Research Center (2018), the tax schedule was changed from 7

**Table 4.** Level of Understanding of the CSU millennial employees to the provisions of TRAIN Law

| Indicator | Mean | Verbal Description |
|---|---|---|
| Change in income tax liability derivation | 3.25 | Somewhat understood |
| Change in income tax Schedule | 2.98 | Somewhat understood |
| The highest taxable income on the schedule is 8 million, and is subject to a 35% marginal rate | 2.75 | Somewhat understood |
| Tax exemption for 250,000 annual income | 4.07 | Moderately understood |
| Repeals BPE, AE, and PHHI | 2.89 | Somewhat understood |
| Retains income tax exemption for minimum wage earners | 3.83 | Moderately understood |
| Tax exemption to de minimis benefits/ contributions (GSIS, SSS, Philhealth, and Pag-IBIG) | 3.12 | Somewhat understood |
| An optional 8% tax on gross receipts/sales for SEPs | 3.11 | Somewhat understood |
| Increase the amount of the tax-exempt benefits ceiling | 2.93 | Somewhat understood |
| A decrease in the income tax percentage after the first five years of implementation | 2.76 | Somewhat understood |
| **Overall Mean** | **3.17** | **Somewhat understood** |

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brackets based on NIRC (1997) to 6 brackets under the TRAIN law. Its minimum bracket changed from an income of P10,000 subject to 5% tax liability in NIRC (1997) to P250,000 with 0% tax in TRAIN law (See Appendix A, Tables 9 and 10). Provisions 2 and 3 discuss similar provisions, which are the tax table changes, but they are different in terms of specification. Provision 2 discusses the general change in the tax schedule, while Provision 3 talks about the change within the table. Its focus is the change in the highest bracket of the tax schedule, where taxable income worth 8 million is subject to a 35% marginal rate. Compared with the previous regime of tax, there are seven (7) brackets, with the highest amount of taxable income being only P500,000 and is subject to a P125,000 tax with a 32% marginal rate (See Appendix, Tables 9 and 10).

Provision 4 has the highest mean result (4.07). The provision pertains to the change in the level of tax exemption for an individual with an annual income of P250,000. Before the implementation of the TRAIN law in 2018, the National Internal Revenue Code (NIRC) of 1997 had the following promulgations for those who are not required to pay the annual tax and who are exempted from income tax.

*The following individuals are not required to file an annual 'income tax return':*

- *An individual whose gross income does not exceed his total personal and additional exemptions for dependents (supra), except if engaged in business or practice of a profession, regardless of the amount of gross income.*
- *An individual earning from 1) a single employer, 2) pure compensation income, 3) derived from sources within the Philippines, and 4) the income tax which has already been correctly withheld by the employer.*
- *An individual whose income consists solely of interest, prizes, royalties, etc., subject to the payor and paid by him to the Bureau of Internal Revenue; and*
- *A minimum wage earner or an individual who is exempt from tax under the Tax Code or other laws.*

In the current law, DOF (2018) highlighted that those with a net taxable income of P250,000 are exempt from income tax. These effective tax rates will be lowered for 99% of taxpayers except the richest with taxable income above P8 million, who will face a tax rate of 35%. Manasan (2017) further stipulated that the PIT liability of an entry-level DepEd teacher who earns around P20,000 per month will become zero under HB 4774 or the current TRAIN law, compared with P22,500 under the old PIT regime (if she/he has two children) or P35,000 (if she/he has no children).

Provision 5 discusses the repealing of BPE, AE, and PHHI. The mean result (2.89) is interpreted as somewhat understood. In the National Internal Revenue Code (1997), there are allowable exemptions or deductions to lessen the taxable income. The following are the basic personal exemptions (BPE), AE (Additional Exemptions), and Premium on Health and Hospitalization Insurance (PHHI). The NIRC has the following promulgations and definitions for the allowable exemptions;

*There is also allowed like a deduction from the amount of taxable income, whether compensation or not, the basic personal exemption of 50,000 for each taxpayer, regardless of status (i.e. that married or single, with or without qualified dependent):*

*The additional exemption of 25,000 for each qualified dependent but not exceeding four (4) dependents may be claimed by one of the spouses in the case of married individuals.*

*A dependent means a legitimate, illegitimate, or legally adopted child chiefly dependent for support upon and living with the taxpayer if such is dependent is (a) not more than 21 years of age, (b) not married, and (c) not gainfully employed except in the case of children, even if more than 21 years of age, when they are incapable of self-support because of mental or physical defects.*

These exemptions were all removed in the TRAIN law. This means that the amount stipulated in the tax schedule for a specified annual income and its corresponding tax liability is already derived in itself. Compared to the previous NIRC, there are still deductions that is needed to be applied to arrive at the actual taxable income. All these complex derivations were simplified and included in the concept of exempting employees with an annual income of P250,000.

Provision 6 covers the stipulation on retaining the tax exemption for the minimum wage earner. Its mean result (3.83) is interpreted as moderately understood. In NIRC, tax exemption is for those individuals whose gross income does not exceed the

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sum of their BPE and AE. The TRAIN law generally applies the concept of income tax exemptions used in NIRC, which are exemptions for minimum wage earners and individuals with income below the total of their BPE and AE. In addition, it increased the maximum annual income exemption from Php 150,000 as the sum of BPE and AE with four (4) dependents, to Php 250,000 in TRAIN Law.

Provision 7 covers the understanding of Tax exemption to de minimis benefits and mandatory contributions, i.e., GSIS, SSS, Philhealth, and Pag-IBIG. According to the Department of Finance – National Tax Research Center (2018), the TRAIN law retains the exemption on the tax benefits as well as the non-taxability of mandatory contributions such as those made to the GSIS, SSS, PhilHealth, PAG-IBIG fund, and union duties. This specifies that the following promulgations were already present in NIRC and retained on TRAIN law. Provision 8 covers the understanding of an optional 8% tax on gross receipts/sales for SEPs. Self-employed and professionals or SEPs are individuals earning income not dependent on compensation income which is provided by the employers to employees, received on a monthly basis but rather based on business or by the practice of a profession, e.g., doctors and lawyers. In the TRAIN law, the SEPs could either opt to be taxed based on regular PIT rates or 8%. However, according to DOF-NTRC (2018), the optional 8% tax is only permitted for those SEPs with annual gross sales/receipts of P3 million and below. Those SEPs with higher annual gross sales/receipts are taxed based on the regular PIT rates.

Provision 9 specifies the provision for increasing the tax-exempt benefit ceiling and other benefits. According to DOF-NTCR (2018), the first PHP 90,000 of the 13th-month pay and other bonuses will be exempt from income tax. This is compared to the previous tax-exempt ceiling of P82,000. Lastly, provision 10 covers the discussion on the tax per income based on the tax schedule. In the first five years of the TRAIN law, the tax schedule had higher tax percentages on income compared to the year 2023. This is based on the adjustment of taxes after being able to reach the government revenue needed to finance its multifarious activities, which was named by the current administration as the "Build Build Build program."

All the provisions except Provisions 4 and 6 are interpreted as somewhat understood and operationally defined, as the respondent has a basic and partial understanding and may be able to explain and apply them, but lacks depth. In terms of provision 1, which covers changes in income tax liability derivations, respondents may have an idea about the concept but do not fully grasp the process of its derivations, which may include tax exemptions and deductions, which were later changed in the new policy. This is also similar to the rationale behind the change in the tax schedule and percentages of its marginal rates, which supplemented the intention to reduce the burden of taxation to the lowest brackets of income earners and put higher liabilities on the higher brackets of income earners (Provisions 2 and 3). The result of provision 5 implies that employees have a partial and basic understanding of the concepts for deriving taxable income, tax liability, and tax due, which uses allowable deductions.

This operationalized middle level of understanding and technical know-how can also be attributed to the typical process of income tax derivation in an organization within the Philippines' systems, which is not typically done by the employee, leading to a lack of indispensability and obligation of knowing its nature and dynamics. In provision 7 and 9, the level of understanding of tax exemption of de minimis benefits and increasing the ceiling of benefits (13th month pay and other bonuses) can also be linked to the nonpermanent employment status of workers, who do not have an employer-employee relationship, leading to either personal acquisition or no de minimis benefits and benefits at all. While those who are recent in the permanent status may have been in the process of orienting themselves to the nature of de minimis benefits. While provision 8 level of understanding can also be linked to the nature of income. Employees are classified as compensation income earners (CIE); the optional 8% is solely applicable to self-employed and professionals (SEP). However, the knowledge of this alternative percentage for taxation is still applicable to individuals who are both CIE and SEP. Lastly, provision 10 covers the knowledge of policy implementation itself. Similar to provisions 1 and 2, which mentioned changes in tax schedule marginal rates, this change will also decrease after the first five years of implementation. The level of understanding can be similarly attributed to the aforementioned implications.

In terms of provisions 4 and 6, both are interpreted as moderately understood. This is operationally defined as the respondent having a clear grasp of the provisions and capable in explaining and applying

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most of the key concepts correctly. This implies that among the provisions mentioned in the policy amendment, these are most clearly communicated and understood by the employees. This also means that the employees can apply to their context in comparison to various organizational income levels and the local policies on minimum wage. Though all of the provisions have usability among the employees, these provisions are the most likely to be applicable given that this information is applicable to those with income who are in the entry level and regardless of employment status, which is common among millennial employees. In its entirety, it is imperative that as an employee whose relationship to taxation is inherent, there is a need for improvement in understanding the nature and dynamics of income tax. Having a good understanding of the processes of taxation can be useful in various economic decisions.

***b. Spending preference of the millennial employees from the increase in take-home pay***

This section covers the discussion on the spending preference of millennial employees from their increase in their take-home pay. Specifically, this tells the ranking of expenditures where the increase in take-home pay was appropriated. These expenditures were then ranked from 1 to 10 based on the respondents' priorities. Rank 1 represents the most prioritized expenditure, while rank 10 represents the least prioritized expenditure. In a discussion connecting consumption and generation cohorts, the millennial generation is a highly significant group that contributes to a great number of consumer populations. With the population reflecting purchasing power, this impinged on the attraction of many consumer industries. It escalated the importance of studying the group, for they have different behaviors compared to previous generations. (Smith 2011). Orozpe (2014) highlighted that it is imperative to study the generation. It has been posited that in the year 2017, millennials will represent 50% of global consumption. Furthermore, Meister (2012) claims that Generation Y "will be roughly 75% of the global workforce by 2030." The environment where millennials have grown provides technology with a platform for personalization and immediate gratification in all aspects of life (Moreno et al., 2017, p. 140). With the relationship between millennials and consumption elucidated, Table 5 presents the simplified distribution of frequency and percentages of expenditures ranked by millennial employees. The ranks on each expenditure were the highest scored rank out of 153 respondents. These numbers were also set as the basis for its ranking.

Food (Expenditure 1) is the most prioritized expenditure in which the increase in take-home pay was appropriated among the CSU millennial employees. According to FIES, 41.9 percent of the average annual income of a family was spent on food, and this is true for all families in the Philippines (PSA, 2017). Household bills (expenditure 3) were the second most prioritized expenditure of millennial employees. In the study, these include the following: house rent, electricity, water, and telecommunication bills. In FIES, Housing, Water, Electricity, Gas, and Other Fuels refers to the total family expenses for actual and imputed rentals of housing and consumption of water, electricity, gas, and other fuels during the reference period. Also, Filipino family expenditures ranked rental, or house rent, as the second-highest item, accounting for 12.2%. The third highest is 7.9%, expenditures on water, electricity, gas, and other fuels (PSA 2017).

**Table 5.** Distribution of the spending preference of millennial employees from the increase in take-home pay

| Expenditures | Rank | Frequency (n=153) | Percentage |
|---|---|---|---|
| Food | 1 | 111 | 72.54 |
| Clothing | 6 | 27 | 17.64 |
| Household bills | 2 | 67 | 43.79 |
| Medicines and other health expenses | 3 | 34 | 22.22 |
| Educational expenses | 4 | 26 | 17.00 |
| Entertainment and Recreational Activities | 8 | 33 | 21.57 |
| Payment of loans and borrowings | 5 | 24 | 15.68 |
| Savings | 7 | 34 | 22.22 |
| Investment | 9 | 39 | 25.50 |
| Insurance | 10 | 45 | 29.41 |

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The third rank is Expenditure 4, the medicines, and other health expenses. In a generation cohort study, both Generation Xers and Millennials allocate about seven-tenths of their healthcare budgets to health insurance. Further similarities are also reflected in their expenditures on medical services, drugs, and medical supplies (Paulin 2018). The fourth most prioritized expenditure by the millennial employees is educational expenses (Expenditure 5). In the study by Paulin (2018), millennials are mostly educated compared to the prior generations. This reflects their attendance and completion of a college-level program. Further, the farthest observable gap is with the oldest generation. Millennial college attendance almost doubled in percentage as compared to the GIs (72% compared with 40%).

The fifth-ranked priority is the expenses on payment of loans and borrowings (Expenditure 7), while the sixth-ranked priority is clothing (Expenditure 2). In a study on millennials and their expenditure on clothing, it is stated that the consumption of luxurious brands is highly observable to this generation, for they are inclined to use consumption to acquire status, personality, and a sense of rebellion. The identity of this generation is highly tied to the concept of fun and rebellion (Francis & Burgess, 2015). Another study presented that common purchases made by the generation are clothing, shoes, sports equipment, jewelry, health and beauty, entertainment, and food (Valentine & Powers, 2013). In the case of luxurious products, the group is more oriented to the consumption of specific products in support of status, which shows wealth and purchasing power (Lissitsa & Kol, 2016). Millennials tend to spend their income faster compared to previous generations. This highlights their life philosophy of living in the moment and mediating work life with personal life. Thus, the group is a regular traveler, and they like collective learning, simultaneous giving of opinions, in a way that they influence their peers and like to be considered as experts (Moreno et al., 2017).

The seventh-ranked priority is the savings (Expenditure 8), while entertainment and recreational activities (Expenditure 6) were ranked eighth. In a study of generation cohorts and their expenses concerning the entertainment budget across the other generations, spending on entertainment does not exhibit any discernible patterns. For example, shares for fees and admissions are substantially larger for Generation Xers (29%) than for the other groups (19 to 22%). However, Millennials spend more than Generation Xers or Baby Boomers on audio and visual equipment, perhaps because that category includes video games (software, hardware, and accessories) in addition to the aforementioned cable and satellite television (Paulin 2018). The ninth-ranked expenditure was the investment (Expenditure 9), and the last-ranked expenditure was insurance (Expenditure 10).

The study provided information on which areas of expenditure the millennials are associated with in terms of the satisfaction of the need. The spending preference reflects the spending behavior of an individual. As presented, the most prioritized were food, household bills, and medicines and other health expenses, while the least prioritized were savings, investment, and insurance. In relation to the need theory, the spending decisions by the employees can be based on the most immediate need of the employees. In their contexts, any additional income will be appropriated to the essential needs. Though savings, investment, and insurance are classified as essentials in financial planning and security dimensions, in terms of ranking, which needs must be satisfied, a more objectively identified need will be chosen. The age group classification mentioned in the discussion above also places importance on the rank, given that clothing and recreational activities also ranked higher than investments and insurance. The theory further supports this context as it asserts that as the income and wealth of an individual increase, there will also be an increase in well-being. This is justified by the idea that money is used to satisfy an individual's basic psychological and physiological needs. Howell and Howell (2008) pointed out that money fulfills certain higher-order needs if it is properly spent. Money is utilized to satisfy higher-order needs, which can be associated with well-being in opulence. The implication of higher-order needs and financial security on subjective well-being is partly analogous to Cummins' control, internal buffer, and the second level of Maslow's hierarchy (1943) that is defined by the drive to be free from fear, unpredictability, and danger, whether psychological or physical. This means that as the millennial employees met the indispensable needs, they will proceed with spending money on what is likely significant to their context, i.e., educational expenses, payment of loans, recreational, and savings.

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**Table 6.** Relationship between the level of understanding and spending preferences of millennial employees

| Understanding of TRAIN Law | Prioritization of expenditure | Correlation coefficient (r) | P-Value | Remarks |
|---|---|---|---|---|
| Level of Understanding | Food | -.072 | .377 | not significant |
| | Clothing | .057 | .481 | not significant |
| | Household bills | .038 | .640 | not significant |
| | Medicines and other health expenses | .052 | .523 | not significant |
| | Educational Expenses | .001 | .994 | not significant |
| | Entertainment/ recreational activities | .012 | .886 | not significant |
| | Payment of Loans and borrowings | .013 | .869 | not significant |
| | Savings | -.034 | .676 | not significant |
| | Investment | -.082 | .312 | not significant |
| | Insurance | .088 | .277 | not significant |

*Spearman Correlation **tested at 0.05 level of significance
***0.00-.020 Very Weak; 0.21-0.40 Weak; 0.41-0.60; 0.61-0.80 Strong; 0.81-1.00 Very Strong

***c. Test of the significant relationship between the level of understanding to TRAIN law and the spending preference of the millennial employees***

This section presents the correlation between the level of understanding and the spending preference of millennial employees. The variables tested are under the categorical data, which have not fulfilled the assumptions for normally distributed data. Hence, the data tested were not normally distributed, which required the nonparametric tests. The level of understanding presents categorical data and is tested with the respondents' prioritization of expenditures, which are the ranked data. The level of understanding is tested with each of the ranked expenditures to get the correlation coefficient.

Table 6 presents the results of the correlation between the stated variables. All the ranks tested with the level of understanding have a p-value higher than the level of significance. This means that the test failed to reject the null hypothesis, which failed to prove the alternative hypothesis. This means that currently and contextually, the level of understanding and the prioritization of expenditure of the employees are not significantly correlated. The non-significant result can be linked to various reasons. First, the overall mean level of understanding is interpreted as somewhat understood. This implies that a neutral mean score does not directly affect the spending decisions and behavior of the employees. It can also be a good exploration if the age group is not homogeneous. Second, most of the respondents are on the entry-level income, which does not provide a significant amount of take-home pay that will alter their spending behavior and decision. This means that regardless of the additional take-home pay of the millennial employees, the priority expenditure will still be similar. This is unless a significant amount of additional take-home is added to the employee's disposable income. Lastly, multiple factors may alter ranked decision making, this may include individual goals, family arrangement, work setup, and other social and economic factors. This may limit change in income tax rates as a stand-alone factor that alters prioritized ranked expenditure among the millennial employees. Supplemented by the income need theory, economic behavior persists and fluctuates depending on the stimulus provided by the very milieu an individual is conditioned, in this context, the millennial workers of CSU.

Despite the result, it is important to note that a failure to reject does not mean that the null hypothesis is true. Rather, it pertains that the test failed to prove that the alternative hypothesis is true. With this, the descriptive and inferential results can still be used for future policy analysis, organization studies, and other related variables for future studies. Key recommendations include increasing platforms for the development of taxation literacy, financial literacy, and responsible spending behavior, and access to various forms of economic support for employees regardless of employment status.

## 5 Conclusion

The study revealed that millennial employees have a middle-level understanding of the change in income tax rate provisions of the TRAIN law.

Given the additional increase in take-home pay due to restructured income tax rates, the millennial employees' prioritized expenditures revolved around food, household bills, and medical expenditures, which are classified as physiological and security needs in the need theory classification, while the least prioritized are investments and insurance, which are under financial planning and security dimension. This further emphasizes that once the millennial employees receive additional funds, this will be appropriated towards physiological and security needs. Further, the test for the relationship between the two variables showed no significant relationship, which can be attributed to various factors, i.e., middle-level understanding of change in income tax provisions (TRAIN Law), entry-level income of millennials, which has a low change in take-home pay, and various contextual individual and filial factors that may not alter ranked prioritized expenditures.

## Declaration of interests

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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***Appendices***

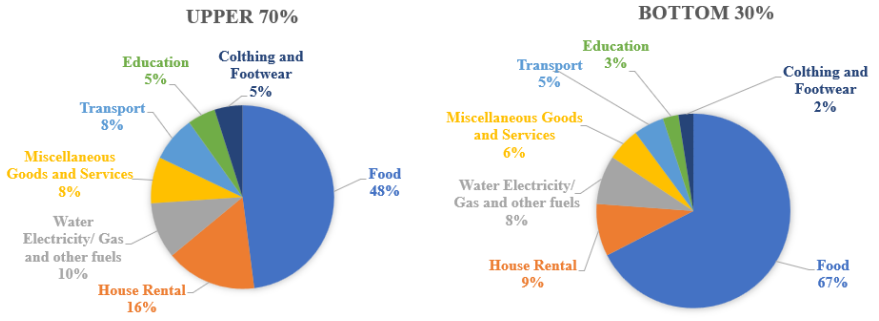


**Figure 2.** Expenditure Pattern of the bottom 30 percent and upper 70 percent per capita income groups: 2015
*Source: Philippine Statistics Authority - FIES 2017*

**Table 7.** Salary Standardization Law (Effectivity: January 1, 2019)

| Salary Grade | Step 1 | Step 2 | Step 3 | Step 4 | Step 5 | Step 6 | Step 7 | Step 8 |
|---|---|---|---|---|---|---|---|---|
| 1 | 11,068 | 11,160 | 11,254 | 11,348 | 11,443 | 11,538 | 11,635 | 11,732 |
| 2 | 11,761 | 11,851 | 11,942 | 12,034 | 12,126 | 12,219 | 12,313 | 12,407 |
| 3 | 12,466 | 12,562 | 12,658 | 12,756 | 12,854 | 12,952 | 13,052 | 13,152 |
| 4 | 13,214 | 13,316 | 13,418 | 13,521 | 13,625 | 13,729 | 13,835 | 13,941 |
| 5 | 14,007 | 14,115 | 14,223 | 14,332 | 14,442 | 14,553 | 14,665 | 14,777 |
| 6 | 14,847 | 14,961 | 15,076 | 15,192 | 15,309 | 15,426 | 15,545 | 15,664 |
| 7 | 15,738 | 15,859 | 15,981 | 16,104 | 16,227 | 16,352 | 16,477 | 16,604 |
| 8 | 16,758 | 16,910 | 17,063 | 17,217 | 17,372 | 17,529 | 17,688 | 17,848 |
| 9 | 17,975 | 18,125 | 18,277 | 18,430 | 18,584 | 18,739 | 18,896 | 19,054 |
| 10 | 19,233 | 19,394 | 19,556 | 19,720 | 19,884 | 20,051 | 20,218 | 20,387 |
| 11 | 20,754 | 21,038 | 21,327 | 21,619 | 21,915 | 22,216 | 22,520 | 22,829 |

*Source: GovernmentPH*

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**Table 8.** Tax Schedule based on NIRC

| National Internal Revenue Code (NIRC) Republic Act 10653 | | |
|---|---|---|
| **Over** | **But Not Over** | **Rate** |
| | ₱10,000 | 5% |
| ₱10,000 | ₱30,000 | ₱500 + 10% of the excess over ₱10,000 |
| ₱30,000 | ₱70,000 | ₱2,500 + 15% of the excess over ₱30,000 |
| ₱70,000 | ₱140,000 | ₱8,500 + 20% of the excess over ₱70,000 |
| ₱140,000 | ₱250,000 | ₱22,500 + 25% of the excess over ₱140,000 |
| ₱250,000 | ₱500,000 | ₱50,000 + 30% of the excess over ₱250,000 |
| ₱500,000 | | ₱125,000 + 32% of the excess over ₱500,000 |

**Table 9.** Tax Schedule based on TRAIN law

| Tax Reform for Acceleration and Inclusion Law (TRAIN Law) Republic Act 10963 | | |
|---|---|---|
| **For the taxable year 2018-2019* | | |
| Over | But Not Over | Rate |
| | ₱250,000 | 0% |
| ₱250,000 | ₱400,000 | 20% of the excess over ₱250,000 |
| ₱400,000 | ₱800,000 | ₱30,000 + 25% of the excess over ₱400,000 |
| ₱800,000 | ₱2,000,000 | ₱130,000 + 30% of the excess over ₱800,000 |
| ₱2,000,000 | ₱8,000,000 | ₱490,000 + 32% of the excess over ₱2,000,000 |
| ₱8,000,000 | | ₱1,450,000 + 35% of the excess over ₱8,000,000 |

**note that deductions or exemptions are not allowed in the TRAIN Law*

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## CONTENT



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