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Effectiveness of *Mangifera Indica, Carica Papaya,* and *Citrus Limon* Peels as Bio-Floor Wax for Classroom Use in the Philippines

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ABSTRACT

The Philippines has a tradition of using floor wax to enhance the shine and durability of floors. However, commercial floor wax often contains harmful chemical substances that pose significant health risks. The study evaluated the potential of *Mangifera indica*, *Carica papaya*, and *Citrus limon* as bio-floor wax. Using a quantitative research approach, the research examined the odor, shininess, friction, and water resistance properties of these fruit peels. An antimicrobial sensitivity test was also conducted, and the mango extract had the highest average inhibition zone, while the combined extract had the lowest. The results showed that lemon peels have the highest friction on ceramic tiles, while papaya peels performed best on wood flooring. Mango peels showed the highest shininess on scarlet oak surfaces. The water resistance test showed no significant differences across different tiles. The results showed that the fruit peels could be a viable option for bio-floor wax in Philippine classrooms. Further research is recommended to develop formulations suitable for broader applications and to validate the product's performance under different environmental conditions.

Keywords:- *Bio-Floor Wax, Fruit Peels, Extract, Testing Of Physical Properties, Antimicrobial Sensitivity Test.*

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TABLE OF CONTENTS

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/IJISRT24JUN1171

CHAPTER ONE
INTRODUCTION

A. Background of the Study

The Philippines is one of the known countries for its fondness of using floor wax to make the floors shine. It is one of the Filipino traditions. Floor wax was a polishing and finishing agent based on wax. It was intended to make flooring glossier and more durable, as well as to make it more resistant to scuffs and slides. Floor wax frequently contains formaldehyde, cresol, and potentially dangerous substances like phenol, toluene, nitrobenzene, perchloroethylene, and xylene. While cresol can damage the liver and kidneys, formaldehyde is dangerous and can be found in commercial cleansers (West, 2019). According to Marks (2023), formaldehyde, a common indoor gas, has been linked to respiratory, cancer, and lung damage with many animals potentially dying from its irritation of the upper respiratory system. This study aims to rule out any negative health impacts in terms of respiratory and dermatological side effects. For generations, floor wax has been a widely used floor maintenance product. Nonetheless, it affects people's health in some way. Per- and polyfluoroalkyl substances (PFAS) in dust and airborne particle matter during professional floor stripping and waxing were assessed in a study earlier this year. Researchers found that there were noticeably high levels of PFAS present during floor waxing after assessing the process's emission rates (UNC Gillings School of Global Public Health, 2022). It has increased occupational health risks for workers. Exposure to PFAS may be linked to harmful health effects, including an increased risk of cancer, immunotoxicity and neurodevelopmental problems. According to the report by Aglibot (2018), Olongapo City National High School sent ten of its Grade 9 students to the hospital after they had a bad reaction to the floor wax, they were using in the classroom. They reported experiencing nausea, abdominal pain, and breathing problems. While there have been studies on the use of *Mangifera indica* Lin (mango) peels as an alternative to floor wax (Gabrido et al., 2019) and other studies have explored the potential of *Musa Paradisiaca* (banana) peels for the same purpose (Center, 2020), there appears to be a research gap in the studies of *Mangifera indica* (mango), *Carica papaya* (papaya), and *Citrus limon* (lemon) peels for this application. Specifically, no studies were found that directly observe the effectiveness of these three types of fruit peels as alternatives to commercial floor wax for household use in the Philippines. This gap suggests a need for further research to determine which fruit peels provide the most effective and sustainable alternative to commercial floor wax. Such a study could contribute to developing more environmental friendly and cost-effective household products. This information allows researchers to develop models and identify important factors associated with commercial floor wax (UNC Gillings School of Global Public Health, 2022). For individuals accustomed to using conventional floor wax to enhance the luster of tiled or cement floors in educational settings, there exists a compelling alternative: mango, papaya, and lemon peels. These natural substitutes will offer a sustainable solution for waxing and polishing floors, catering to the needs of parents and household cleaners alike. This research study not only sheds light on the effectiveness of the three alternative floor wax options but also empowers students to critically assess their practicality. Through this exploration, students will gain insights into the functional, resourceful, and efficient aspects of these alternatives, thereby broadening their understanding of sustainable practices in everyday contexts. This research enables the development of appropriate strategies to decrease the disadvantages and negative impact of commercial floor wax while maintaining public health and safety.

B. Purpose Statement

This research study aims to conduct a thorough analysis to discern the differences in friction, shininess, odor, and water resistance characteristics exhibited by three distinct fruit peels proposed as an alternative to conventional commercial floor wax. Embedded within these fruit peels are that offer antimicrobial benefits, a feature that stands at the forefront of this study's contribution to the field. By providing insights into these properties, the research aims to enhance the safety and environmental sustainability of floor wax products. By meticulously examining these properties and providing insights, the study aims to contribute valuable knowledge to the field of commercial floor wax, particularly in addressing growing concerns regarding product safety and environmental sustainability on a global scale. Furthermore, beyond its scholarly significance, the research holds the potential to catalyze the development of a cost-effective alternative commercial floor wax, offering potential benefits to households and public schools in the Philippines while simultaneously promoting waste management through the utilization of fruit peels as recyclable raw materials. In essence, this research underscores a professional commitment to rigorous inquiry and actionable outcomes. By addressing critical gaps in understanding and advocating for sustainable practices, it aims to drive positive changes toward a future where innovation together with environmental stewardship, promotes resilience and prosperity for communities worldwide.

C. Research Questions

- *What is the assessed effectiveness of Mangifera indica (mango), Carica papaya (papaya), Citrus limon (lemon) peels, and combined peels as bio-floor wax according to:*

- Friction
- Shininess
- Odor
- Water Resistance

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- *Is there a difference between the effectiveness of Mangifera indica (mango), Carica papaya (papaya), Citrus limon (lemon) peels and combined peels as bio-floor wax in terms of friction, shininess, odor, and water resistance?*
- *How does the effectiveness of the floor wax vary when made from different concentrations of Mangifera indica (mango), Carica papaya (papaya), and Citrus limon (lemon) peels? Specifically, in the following formulations:*

- A combined mixture with equal parts of *Mangifera indica* (mango), *Carica papaya* (papaya), and *Citrus limon* (lemon) peels (each constituting 1/3 of the mixture).
- A formulation with 1/4 concentration of *Mangifera indica* (mango) peel extract.
- A formulation with 1/4 concentration of *Carica papaya* (papaya) peel extract.
- A formulation with 1/4 concentration of *Citrus limon* (lemon) peel extract.

- *How do the antimicrobial compounds extracted from the peels of Mangifera indica (mango), Carica papaya (papaya), and Citrus limon (lemon) differ?*

D. Research Hypothesis

Null Hypothesis: There is no significant difference between the assessed effectiveness of mango, papaya, lemon, and mixture of the peels.

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CHAPTER TWO
LITERATURE REVIEW

This chapter features the overview of Related Literature and Studies that support the study. This provides relevant studies related to *Mangifera indica* (mango), *Carica papaya* (papaya), and *Citrus limon* (lemon) peels. This includes the scope of the review, main findings of the thematic areas related to the research question, and the research gap.

A. Component of Floor Wax

Despite having articles about the components of floor wax, it does not mention the safety precautions that should be taken when using floor wax. Floor wax is a liquid chemical mixture that, when applied to a surface and allowed to dry, forms a thin, hard, protective layer (What Are the Ingredients in Floor Wax, 2021). Water, preservatives, polymer emulsions, film formers, and modifiers are the five primary groups into which floor wax ingredients can be divided. Deionized water is utilized in the manufacturing of floor waxes. It ensures that contaminants that cause color, such as iron, do not become dried into the floor wax. Preservatives are put on the floor and floor wax to stop them from deteriorating, discoloring, or smelling bad. While the polymer emulsion serves as a link between all other elements in the mixture and influences the performance qualities of the floor wax, Furthermore, the film formers form a glue that holds the polymer emulsions to the water, preventing the polymer emulsions from crystallizing on the floor's surface after drying. To increase the desired performance characteristics of floor waxes, modifiers such as resins, cross-linkers, ultraviolet stabilizers, and wax emulsions are added to the polymer emulsions. Floor wax protects the floor from liquid damage and provides gloss, extra hardness, and slide and scuff resistance. Floor wax is a solution that has been used extensively for centuries for floor care. Most people today prefer manufactured and synthetic floor waxes that are comparatively easy to apply. When maintained and applied correctly, floor waxes offer a high shine, which is advantageous for commercial and business spaces (Tcsfloors, 2016). They can be used on any flooring, including concrete, ceramic, and vinyl. Moreover, floor waxes are created to resist scratches and repel stains and abrasions. They take care of high-traffic areas, providing a protective layer that helps maintain the appearance and longevity of the floor surface. Commercial waxes are typically made to last. They are synthetic materials or a mix of artificial and natural ingredients. However, eco-friendly waxes are made from natural materials like linseed oil, beeswax, carnauba wax, rosemary oil, and other sustainable natural waxes.

B. Health Impact of Commercial Floor Wax

Despite having a study about the health risks associated with exposure to the harmful chemicals in floor wax, there is a lack of study on the long-term health effects on individuals exposed to these chemicals over an extended period. Per- and poly-fluoroalkyl substances (PFAS) in dust and airborne particle matter during professional floor stripping and waxing were measured in this study. It was discovered that when floors were waxed, PFAS levels were considerably higher. Adverse health effects have been attributed to PFAS exposure. According to the study, PFAS exposure may raise the hazards to the occupational health of floor waxing workers. These hazards include a higher chance of immunotoxicity, cancer, and neurodevelopmental issues (UNC Gillings School of Global Public Health, 2022). Ten high school students at Olongapo High School, all in Grade 9, fell ill due to a bad reaction to the smell of floor wax they were applying in their classroom. The students complained of stomach aches, nausea, and breathing problems (Aglibot, 2018). This incident serves as a reminder of the possible health dangers of being around certain chemicals, such as those in floor wax. Floor wax, containing harmful chemicals like Cresol, Nitrobenzene, and Xylene, can cause liver and kidney damage, cause health complaints like dizziness, nausea, and coughing, and be explosive, potentially causing long-term adverse effects in aquatic environments (Author, 2020). Proper floor buffer care is crucial for safety.

C. Production Rates and Accessibility of Mangifera indica (Mango), Carica papaya (Papaya), and Citrus Limon (Lemon)

Despite the significant agricultural production of *Mangifera indica* (mango), *Carica papaya* (papaya), and *Citrus limon* (lemon) in the Philippines, there appears to be a lack of research studies integrating the environmental impacts associated with their production processes. The Philippine Statistics Authority (2023) reports on mango production, while the ISPs platform (2022) discusses challenges and strategies in the industry. Moreover, Food Philippines (2022) and The Mango Factory (2020) highlight the importance of mangoes and the potential of organic farming. Research by Magdalita et al. (2021) and the Business Diary Philippines (2020) guide focus on papaya cultivation and drought tolerance. An analysis (2023) profiles the citrus industry in Nueva Vizcaya, Philippines. This suggests an opportunity for future research to contribute to this area, potentially leading to more sustainable practices in the agricultural sector.

D. Reducing Fruit Peel Waste for Industrial Applications

The Philippines, an endemic Asian country, is the seventh-top mango producer globally. However, 41% of the remaining mango supply is used for value-added products, leading to significant waste. Five truckloads of waste materials are disposed of daily in dumpsites. A study by Gragasin evaluated pectin quality from native carabao mango peels, aiming to develop USP-standard pectin. It could generate income, create jobs, and minimize solid waste materials, thus reducing the country's environmental impact. Lu et al. (2021) explored using citrus fruit waste to reduce landfill waste. Results show a growing interest, with peels being the most common type. The study uses rigorous processes, pore size, and BET surface area to evaluate waste products, highlighting their potential for waste management. Additionally, UP Mindanao's Bioresource Technology Reports

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explores the possibility of converting calamansi and mango peels into acetic acid for industrial applications, reducing waste and environmental impact and potentially reducing fruit processing costs.

E. Fruit Peels as Alternative to Commercial Floor Wax

The study explores fruit peels' usage as cleaning agents, focusing on floor wax, with limited research on mango, papaya, and lemon peels as alternative floor wax. Caisip, S., & Ranido, A. D. (2019) conducted an investigatory project to create a fruity and affordable floor polish using local fruit peels such as oranges, bananas, and lanzones. The study, "Fruity Mixed Flavoured Floor Wax," aimed to be eco-friendly and avoid strong smells that can cause respiratory problems. Their research found that 11 out of 13 people agreed that their product was more effective, affordable, and eco-friendly than other common waxes. Additionally, they discovered that their product served as an insect repellent with a scent that was not too irritating to users. The wax not only made the floor more slippery but also shiny and presentable, maintaining the quality of the finished floor. Manimtim, S. (2019) conducted a study to create an eco-friendly and affordable floor polish using coconut meat. The coconut meat was processed and mixed with melted candle wax to make three different set-ups. These were tested over a week by replacing the respondent's floor wax with the researchers' samples. The outcomes varied, with the first two set-ups having fewer desirable results. However, the third set-up resulted in a product that resembled ordinary floor wax, was shiny, non-slippery, and overall, was a success. The outcome was beneficial, and its benefits rival those of its commercial counterparts. Mango peelings are materials that are usually discarded by consumers, not knowing that these materials contain high concentrations of pectin. Pectin is an effective stabilizer for floor wax (Gabrido et al., 2019). Using mango peeling pectin as a stabilizer for bio-floor wax could provide a sustainable and eco-friendly alternative to commercial floor wax. However, further research is needed to compare the effectiveness of pectin from mango, papaya, and lemon peels as stabilizers for bio-floor wax. Such research could help identify the most effective and sustainable source of pectin for bio-floor wax formulations. Many alternatives can be used instead of synthetic materials in commercial floor waxes. Surprisingly, banana peels contain numerous nutrients like fiber, vitamin B6, vitamin B12, magnesium, and potassium (Center, 2019). The most common synthetic wax ingredients used in floor wax are cresol, formaldehyde, and hazardous chemicals like nitrobenzene, perchloroethylene, phenol, toluene, and xylene (Center, 2019). Both studies demonstrate the potential of fruit peels as alternatives to commercial floor wax. Banana and mango peel extracts show promise due to their comparable performance to commercial wax in terms of glossiness and durability. These natural alternatives can reduce the environmental and health risks of traditional floor wax while providing similar performance.

F. Protocol and Guidelines for the Extraction of Fruits

The methodology employed by the researchers serves as a robust protocol, providing a framework that ensures the coherence and accuracy of the research process. However, it is noteworthy that the scope of this study is confined to the extraction process from a single fruit species and local fruits. This specificity, while valuable for an in-depth understanding, may limit the generalizability of the findings. Future research endeavors could potentially expand this scope to include a wider variety of fruit species, thereby enhancing the applicability and relevance of the extraction techniques in a broader context. A study conducted by Safdar et al. (2017) utilized the kinnow mandarin peeled; the peels were chopped into small pieces and baked in a hot air oven at 50°C for 48 hours, or until the moisture content dropped to less than 10%. Using a 0.5-mm sieve size in the Cyclotec sample mill, dried peels were ground into a fine powder. The researchers used two techniques for the extraction: maceration and ultrasound-assisted extraction (UAE). The study found that UAE was a more efficient technique, yielding comparatively higher polyphenol contents than maceration, with the highest yield obtained using 80% ethanol. The researchers Magsombol and Magtibay (2020) use the local fruits orange, mango, and papaya in their study. The fruit peelings were meticulously cleaned to eliminate any dirt and foreign particles, then segmented into small pieces and left to air-dry for a week. Following the drying period, the samples were pulverized using an electronic blender. A portion of each powdered sample was set aside for microbial density evaluation to ensure minimal contamination before the antimicrobial assay. The majority of each powdered sample was subjected to a week-long extraction process with 80% methanol to isolate the active constituents. The resulting mixtures were then filtered on Whatman filter paper, and the filtrates were concentrated using a rotary evaporator. Finally, the concentrated extracts were reconstituted with 20% dimethyl sulfate (DMSO) for further analysis. Another study was conducted by Purnamasari (2022) that utilized dragon fruit peel and discussed a method to extract antioxidants from dragon fruit peel for use in natural cosmetics. The process begins with the preparation of the dragon fruit peel, which is cut and mashed. The mashed peel is then subjected to a solvent treatment using varying concentrations of ethanol and HCl for a day. The resulting mixture is filtered to obtain a macerate. This macerate is then evaporated using a rotary evaporator at a temperature of 80–90 °C for a certain time (10, 20, 30, and 40 minutes), and the rate of evaporation is observed. Furthermore, papaya peels are tested for their antibacterial activity. The study utilized solvent extraction techniques to prepare extracts from the leaf and seed of Carica papaya. Each plant powder, weighing twenty grams, was separately dissolved in 200 ml of various solvents, including 80% acetone, 80% methanol, 80% ethanol, and water. The mixtures were prepared in a 250-ml conical flask and soaked for 72 hours until the soluble substances were fully dissolved. Following this, each extract was filtered using Whatman No. 1 filter paper. The filtrates were then dried using a rotary evaporator until all the solvent had evaporated. The resulting extracts were stored in a vial at 20 degrees Celsius for future analysis (Dagne et al., 2021).

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G. Synthesis

The literature assessment reveals a substantial research gap in the use of fruit peels, such as mango, papaya, and lemon peels, particularly as substitutes for floor wax. This gap includes the effects of fruit cultivation, especially in the Philippines, on the environment and the industrial use of fruit peel waste. The study addresses these gaps by exploring the potential of these fruit peels in bio-floor wax formulations and assessing the ecological footprint of fruit production. This study aims to reduce environmental impact, promote sustainable agricultural practices, and establish safety guidelines for floor wax usage, thereby contributing to the discourse on sustainability and addressing both immediate and long-term health implications of commercial floor waxes. It responds to the insufficiency of research in this area. By reviewing relevant literature, the study formulates questions that investigate the effectiveness of varying concentrations of fruit peel wax. Moreover, it also addresses protocols and guidelines for conducting this study, which helps researchers to have a coherent study. The focus is on assessing its friction, odor, shininess, and water resistance properties, comparing them to commercial floor wax. The aim is to clearly understand the viability of these natural materials as alternatives to conventional products. This approach ensures the study's alignment with the identified research gaps and its potential contribution to the field.

H. Research Paradigm

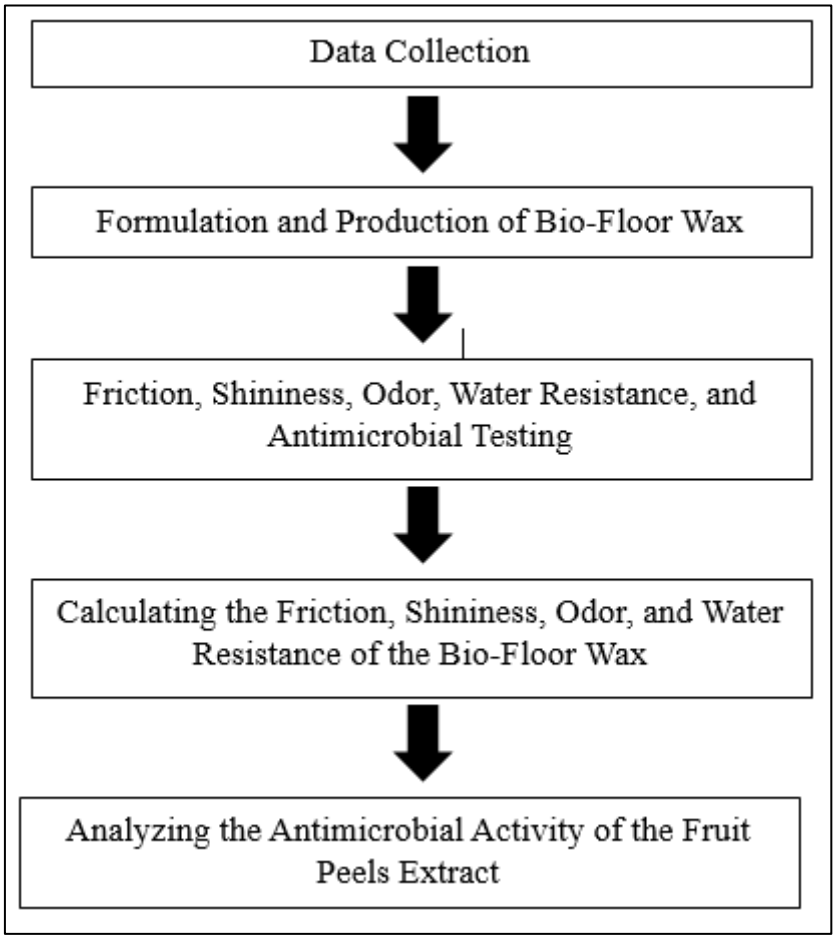

Fig 1: Research Paradigm

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CHAPTER THREE
MATERIALS AND METHOD

A. Research Design

This study will employ an quantitative research design to utilize the scientific method. This approach enables the researcher to test a hypothesis and to study the relationships systematically and scientifically among variables (GCU, 2021). It will allow researchers to review the quantitative findings, addressing the limitations of each method individually and increasing the overall validity of the study. Moreover, this underscores the use of statistical tables, which provide objective evidence to support or refute the research hypothesis.

B. Setting and Participants

The study primarily targets classrooms in the Philippines. The researchers conducted surveys and observational experiments to determine if *Mangifera indica* (mango), *Carica papaya* (papaya), and *Citrus limon* (lemon) peels could serve as an effective alternative to commercial floor wax. Participants in these studies included individuals such as teachers, students, janitors or housekeeping staff, and others with knowledge of both commercial and mango, papaya, and lemon peel bio-floor wax. Using purposive sampling, fifty individuals in Manila, Philippines will be surveyed. Peels from the required plants were obtained from the local markets in Bustillos, Dapitan, and Trabajo, Sampaloc, Manila.

C. Materials

- **Fruit Peels**: The peels of mango, papaya, and lemon were collected. These peels are rich in essential oils and other bioactive compounds, which are hypothesized to contribute to the effectiveness of the bio-floor wax.
- **Drying Oven**: A drying oven was used to completely dry the fruit peels before the blending process. This step is crucial to prevent the growth of mold and bacteria on the peels.
- **Foil**: Aluminum foil was used as a tray for the peels in the drying oven. It facilitates even heat distribution, ensuring that the peels are thoroughly dried.
- **Electric Blender**: A standard kitchen electric blender was used to mechanically break down the fruit peels into a fine powder. This process increases the surface area of the peels, enhancing the extraction of the essential oils and bioactive compounds.
- **Laboratory Mortar and Pestle**: A laboratory-grade mortar and pestle were used to further crush the fruit peel powders that could not be adequately processed by the blender. This manual method allows for greater control over the particle size.
- **60 Mesh 0.3mm Aperture Lab Standard Test Sieve**: This laboratory-grade sieve was used to ensure the uniformity of the fruit peel particles.
- **Storage Jars**: Three separate glass jars were used to store the sieved/fine powders of each fruit peel. Glass was chosen as the storage material to prevent any chemical interaction with the fruit peel powders.
- **Ethanol**: Ethanol, a polar solvent, was used to extract the essential oils and bioactive compounds from the fruit peel powders. Its volatility also makes it ideal for use in a rotary evaporator.
- **Rotary Evaporator**: A rotary evaporator was used to evaporate the ethanol, leaving behind the concentrated extract of the fruit peels. This process is done under reduced pressure, which lowers the boiling point of ethanol and prevents the degradation of the bioactive compounds.
- **Whatman Filter No. 1**: A Whatman filter no. 1, a medium-fast filter paper, was used to separate the solid fruit peel particles from the ethanol extract. This ensures that the final bio-floor wax is free from any solid impurities.
- **Measuring cup and spoon:** These materials are used for the accuracy of the ingredients.
- **Double boiler:** A double boiler is used for melting the beeswax and it helps prevent it from burning.
- **Mineral oil and Beeswax**: These will act as binding agents, giving the wax its solid form and glossy finish.
- **Butane Stove and Butane**: These will provide the heat necessary for melting and mixing the ingredients.
- **Ceramic tiles, Scarlet Oak, Wooden Block, and Coin**: These will be used for testing the effectiveness and durability of bio-floor wax.
- **Light range meter**: This will be used to measure the glossiness of the waxed surfaces.
- **Petri Dish**: This will be used in antimicrobial testing to culture and observe the growth of staphylococcus, and to assess the presence of antimicrobial agents in the fruit peels.
- **Forceps**: These will be used to handle and transfer small samples, such as fruit peels or bacterial cultures, in a sterile and precise manner.
- **Alcohol lamp**: This will be used to sterilize equipment and maintain clean conditions by producing a flame that eliminates contaminants.
- **L-Shaped rod**: This will be used to evenly spread the bacterial culture across the surface of the agar in a petri dish, ensuring consistent and uniform growth for accurate results.
- **Test tubes**: These will be used to prepare, mix, and store various solutions and bacterial cultures under controlled conditions before they are applied to the agar plates.
- **Beakers:** These will be used to measure and mix solutions and hold larger volumes of liquid during experimental procedures.

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- **Staphylococcus Aureus**: This will be used as the target bacteria to assess the effectiveness of the antimicrobial agents present in the fruit peels.
- **Agar broth**: This will be used as a nutrient-rich medium to culture and grow staphylococcus bacteria for following testing and evaluation of antimicrobial effectiveness.
- **Fruit extracts**: These will be used to evaluate its potential effectiveness in inhibiting the growth of staphylococcus.
- **Penicillin**: This will be used as a positive control to compare the effectiveness of the fruit extract against staphylococcus bacteria.

The actual instrument or test used to measure these variables is adopted from a paper similar to the study. The paper is titled "Effectiveness of Musa Paradisiaca (Banana) Peel as an Alternative to Commercial Floor Wax." It was published in the Asia Pacific Journal of Multidisciplinary Research, a journal recognized in the ASEAN Citation Index. The study was conducted by a team from the Faculty of Engineering, Department of Industrial Engineering, at the University of Santo Tomas in Manila, Philippines. The paper presents a comprehensive study on the use of banana peel as an alternative to commercial floor wax, complete with detailed experiments and observations.

D. Procedure

The setup and reactions for the entire experiment will be carried out at ambient temperature and atmospheric pressure. The materials utilized in this study will not be altered or further purified except for the mango, papaya, and lemon peels, which will be cleansed with water as instructed and planned by the researchers.

➢ *Pre-Intervention*

- *Collection*

Fresh peels from the required plants, specifically mango, papaya, and lemon, will be obtained from the local market in Bustillos, Dapitan, Trabajo, Sampaloc, Manila. Concurrently, beeswax will be procured from a hardware store, and mineral oil will be purchased online from Horizon Mineral and Oil, a business that manufactures and supplies oil.

- *Preparation of Fruit Peels*

The fruit peels of mango, papaya, and lemon were collected and carefully selected. These peels were then thoroughly washed under running tap water. This step is crucial to remove any surface contaminants such as dirt, dust, and potential pesticide residues, ensuring the cleanliness of the samples (Villanueva-Magsombol & Magbojos-Magtibay, 2021). Following the washing process, the peels were then cut into pieces of approximately 2-3 cm (Purnamasari, 2022).

- *Drying and Grinding of Fruit Peels*

The cut fruit peels were subjected to sun-drying for 2 to 3 days. This natural drying process helps in the initial removal of moisture. To ensure complete desiccation, the peels were further dried in a drying oven set at a temperature range of 60-70 °C for a duration of 2-3 hours (Tunchaiyaphum, Eshtiaghi, & Yoswathana, 2013). Once completely dry, the peels were ground using an electric blender. For any fruit peel powder that could not be adequately processed by the blender, a laboratory-grade mortar and pestle were employed. This manual method provides greater control over the particle size. The resulting powdered peels were sieved using a 60 Mesh 0.3mm Aperture Lab Standard Test Sieve to ensure the uniformity of the fruit peel particles.

- *Extraction Process*

The dried and powdered fruit peels were mixed using a suitable tool until they were evenly combined. Ethanol, serving as the solvent, was added to the fine powder peels. The mixture was then allowed to sit undisturbed for 24 hours. This duration allows for the efficient extraction of the desired components from the fruit peels (Safdar et al., 2017).

- *Rotary Evaporation*

The mixture was filtered using Whatman filter paper No. 1 to obtain the macerate. This macerate was then placed into the rotary evaporator. The evaporator was set at a temperature of 80-90°C and operated for a specific duration to effectively evaporate the solvents (Plant Extraction Using Rotary Evaporator: A Comprehensive Guide, 2023; Dragon Fruit Peel Extract as Antioxidant Natural Cosmetic Using Rotary Evaporator, 2022). This step results in the concentration of the extract, thereby yielding the extracted product.

➢ *Intervention*

- *Preparation of Double Boiler*

A double boiler was prepared using a cooking pot and an oven-safe bowl. The pot was filled with water, ensuring it was sufficient to provide heat but not so much that it touched the base of the bowl. The bowl was then placed on top of the pot, creating a seal to trap the steam produced by the heated water. This setup was placed on a stove over a low flame, providing a gentle and consistent heat source.

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/IJISRT24JUN1171

- *Melting of Beeswax and Addition of Mineral Oil*

Beeswax, known for its natural protective properties, was added to the bowl of the double boiler. The gentle heat from the stove caused the beeswax to melt gradually, preventing any degradation of its beneficial properties. 1 and 1/2 cup of mineral oil is added to the pot, and then 3/4 cup of beeswax. The ingredients were mixed and stirred slowly using a wooden spoon until they were thoroughly combined, ensuring a homogenous mixture.

- *Transfer of Mixture*

The bowl was carefully removed from the pot once the mixture was not excessively hot. The mixture was then evenly distributed and transferred to three different glass containers, ensuring each container received an equal amount of the mixture.

- *Addition of Fruit Peel Extracts*

Extracts from mango, papaya, and lemon were individually added to separate containers, each containing a mixture of beeswax and mineral oil. Into each container, one teaspoon of the corresponding extracted peel was introduced. Subsequently, for the mixture of peels, 1/4 teaspoon of each extract was incorporated. The concoction was then meticulously stirred until the mixture and the extract amalgamated thoroughly, ensuring the extracts were uniformly distributed throughout the wax.

- *Resting of Product*

The product was then allowed to rest undisturbed for 2-3 days. This resting period is crucial for allowing the wax to harden and the properties of the extracts to infuse into the wax, achieving the best results.

➢ *Post-Intervention*

- *Testing for Friction*

The three alternative floor waxes will be applied to three different materials: ceramic tiles, wood flooring, and scarlet oak. Each material will be adjusted to its respective angle for the friction test. The friction test will be conducted using the tilted plane method, where a coin is placed at the start of the material, and the time it takes to slip from the start to the end of the material is recorded. The plane's angle is gradually increased until the coin begins to slide.

- *Odor Testing*

A survey of at least 50 participants will be conducted to determine the odor level, and an ANOVA will be used to determine it. The criteria for evaluating the odor level are as follows:

✓ No odor
✓ Mild odor
✓ Moderate odor
✓ Strong odor
✓ Very strong odor.

- *Testing for Shininess*

The floor wax derived from the peels of mango, papaya, and lemon will be applied to three distinct areas and the commercial area, each representing a different material: ceramic tile, scarlet oak, and wood block. These materials are chosen to represent a variety of common flooring surfaces. A wide-range meter will be employed to quantitatively measure the shininess of the applied floor wax on these different materials. The results provided by the device will be meticulously recorded for further analysis. This process, from application to measurement and recording, will be repeated ten times to ensure the reliability and consistency of the results.

- *Testing for Water Resistance*

A small quantity of water, approximately 1 mL, is deposited onto a waxed floor using a small spoon or a teaspoon. Following this, the water droplet is left undisturbed at room temperature for an hour. After the hour has elapsed, any residual water is absorbed using a tissue paper or a cloth. The floor is then evaluated using the following grading system:

✓ No watermark
✓ Slight wash marking
✓ Coating has a slight film that turns white
✓ Film turns white, and a spot of foaming is visible
✓ The film is destroyed and turns white completely.

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- *Antimicrobial Sensitivity Test*

The procedure is initiated by inoculating sterilized agar plates with the bacterial culture. Subsequently, each plate is delineated into two distinct quadrants. The first quadrant is with penicillin, serving as the standard antibiotic control. The second quadrant is designated for the application of the test extract derived from fruit peels. To ensure accuracy, the experiment is performed in triplicate for each extract variant, which includes mango, papaya, lemon, and a combination of all three extracts. This methodology facilitates a comparative analysis of the antimicrobial properties of the fruit peel extracts against the efficacy of penicillin.

➢ *Data Analysis*

To determine the appropriate statistical tests for analyzing the data, a normality test using SPSS software will be employed. Researchers from various fields utilize SPSS (Statistical Package for the Social Sciences) software to quantitatively analyze complex data. The SPSS environment encompasses fundamental data management and preparation, descriptive statistics, and common statistical analyses (T-test, ANOVA, correlation, regression) in this introductory level session (Arthur, n.d.). The Shapiro-Wilk test will be used to evaluate the normal distribution of the data, considering its suitability for a sample size of less than 20 and ten repetitions per test. Following the test results, it will be determined whether to use parametric or non-parametric tests.

The ANOVA will be utilized to assess the statistical significance of differences in means among three or more independent groups, as elucidated by Zach (2021). This test, commonly known as a multiple comparison test, is chosen for its ability to effectively investigate variations between means of multiple groups. To ensure accuracy and reliability, each test will be repeated ten times.

- To determine if there is a difference in friction among the four groups (Mango, Papaya, Lemon, and combined mixture of the peels), the One-way ANOVA will be used.
- To determine if there is a difference in shininess among the four groups (Mango, Papaya, Lemon, and combined mixture of the peels), the One-way ANOVA will be used.
- To determine if there is a difference in water resistance among the four groups (Mango, Papaya, Lemon, and combined mixture of the peels), the Kruskal-Wallis Test will be used.

The Kruskal-Wallis Test is a non-parametric technique that checks if samples come from the same distribution. This method is especially beneficial when the data does not assume normality. Unlike the one-way ANOVA, this test does not require the data to be normally distributed and is less influenced by outliers (Bobbitt, 2022). The Kruskal-Wallis Test will be utilized to ascertain the reliability of the water resistance test. This test will be conducted on each individual tile, with each trial lasting for a duration of 1 hour. This rigorous approach ensures the validity of our results.

In addition to these tests, a survey will be conducted to determine if there is an odor associated with the bio floor wax. This survey can be designed to collect subjective data from a sample population who will use the wax and provide feedback on its odor. In the context of the antimicrobial assay, the zone of inhibition is meticulously observed. This involves the precise measurement of the zone's diameter using a caliper. The recorded measurements are then subjected to statistical analysis to calculate the mean and standard deviation. These statistical parameters are essential to determine whether the substance under investigation—presumably, fruit peels—exhibits significant antimicrobial activity. To ensure the validity and reliability of the experimental outcomes, the assay is conducted under controlled laboratory conditions. Moreover, the research team is supervised by an experienced biology educator, which adds an additional layer of academic rigor to the procedure.

➢ *Ethical Consideration*

The researchers will adhere to the ethical principles developed by Libretexts (2023) and Bhandari (2023) to uphold the integrity of the study. Validation of the research and ensure academic integrity throughout the process. Researchers will obtain necessary consent and permits and will uphold the confidentiality of the participants. In managing the data, the researchers will uphold honesty, rigorously avoiding any form of misleading information or biased representation of data findings. The researchers will be transparent about any affiliations, funding within the group, group contracts, and potential conflicts of interest that could impact the study's outcomes. All communication related to the research will be conducted with honesty and transparency, promoting openness and accountability. By adhering to these ethical considerations, the researchers will uphold the standards of scientific integrity and ensure the credibility of the research study.

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CHAPTER FOUR
RESULTS AND DISCUSSION

This chapter entails a detailed interpretation of the results and their significance to the research question. This highlights the comparison of the findings with existing literature, or theories supported by empirical data presented through tables and figures. The results are organized to facilitate a coherent and comprehensive discussion examining the data collected and the statistical analyses performed.

Table 1: Comparison of Fruit Peel Floor Wax Friction on Ceramic Tile at 25° Angle using One-Way Analysis Variance

Group	Mean (seconds)	Standard Deviation	F-Computed	F-Critical	p-value	Interpretation	Decision
Mango	0.5260	0.07427	5.904	2.87	0.002	Significant	Reject H_o
Papaya	0.5700	0.05598					
Lemon	0.6340	0.08289					
Combined	0.5190	0.05859					

Table 1 shows the mean level of friction of the mango, papaya, lemon, and the combined peels in the ceramic tile at 25° angle. As shown above, the lemon has the highest mean level of friction, 0.634 seconds with a standard deviation of 0.082, while the lowest mean level is combined with 0.519 seconds with a standard deviation of 0.058. Moreover, the p-value is less than the level of significance (0.002<0.05), and the F-Computed is greater than the F-Critical (5.904>2.87).

Table 2: Multiple Comparison of Means of Fruit Peel Wax Friction on Ceramic Tile at 25° Angle

Variables	Mean Difference	Standard Error	p-value	Interpretation
Mango-Papaya	-0.04400	0.03078	0.162	Not Significant
Mango-Lemon	-0.10800	0.03078	0.001	Significant
Mango-Combined	0.00700	0.03078	0.821	Not Significant
Papaya-Lemon	-0.06400	0.03078	0.045	Significant
Papaya-Combined	0.05100	0.03078	0.106	Not significant
Lemon-Combined	0.11500	0.03078	0.001	Significant

Table 2 shows the multiple comparisons of means of the four peels in terms of friction on ceramic tile at 25° angle. The table shows that the lemon-combined pair has the highest mean difference (0.115), while the mango-lemon pair has the lowest mean difference (-0.108). Furthermore, mango-lemon, papaya-lemon, and lemon-combined are considered statistically significant since their p-values do not exceed 0.05, whereas the pairs that are considered statistically not significant exceed 0.05.

Table 3: Comparing the Fruit Peel Wax Friction of Ceramic Tile at 15° Angle using Kruskal-Wallis Test

Degrees of Freedom	H-statistics	H-Critical	p-value	Interpretation	Decision
3	9.331	3	0.025	Significant	Reject H_o

Table 3 shows the Kruskal-Wallis test of the four peels in terms of friction on the ceramic tile at 15° angle**.** The table indicates that the degree of freedom is at level 3, while the H-statistics is (9.331), with a H-Critical of 3. Moreover, this is considered as statistically significant since it does not exceed 0.05 (0.025<0.05).

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Table 4: Pairwise Comparison of Means of Fruit Peel Wax Friction on Ceramic Tile at 15° Angle using Kruskal-Wallis Test

Sample 1-Sample 2	Standard Error	H-Statistic	p-value	Interpretation
Mango-Combined	5.225	-1.215	0.224	Not Significant
Mango-Lemon	5.225	-1.493	0.135	Not Significant
Mango-Papaya	5.225	-3.033	0.002	Significant
Combined-Lemon	5.225	0.278	0.781	Not Significant
Combined-Papaya	5.225	1.818	0.069	Not Significant
Lemon-Papaya	5.225	1.541	0.123	Not Significant

Table 4 shows the pairwise comparison of means of the fruit peels in terms of friction on ceramic tile at angle 15°. The table above shows that the lemon-papaya pair has the highest H- statistic (1.818). On the contrary, the mango-papaya pair has the lowest H-statistic (-3.033). Moreover, mango-papaya is considered statistically significant since its p-value is lower than 0.05 and statistically not significant if its p-value is greater than 0.05.

Table 5: Comparison of Fruit Peel Floor Wax Friction on Scarlet Oak at 25° Angle using One-Way Analysis Variance

Group	Mean (lux)	Standard Deviation	F-Computed	F-Critical	p-value	Interpretation	Decision
Mango	0.6030	0.06717	0.561	2.87	0.644	Not Significant	Do Not Reject H_o
Papaya	0.5880	0.06161					
Lemon	0.6200	0.03830					
Combined	0.6050	0.04950					

Table 5 shows the mean level of friction of the mango, papaya, lemon, and the combined peels in the scarlet oak at 25° angle. As shown above, the lemon has the highest mean level of friction, 0.620 seconds, with a standard deviation of 0.038. In comparison, the lowest mean level is papaya with 0.588 seconds, with a standard deviation of 0.061. Moreover, the p-value exceeds the level of significance (0.644>0.05), and the F-Computed is less than the F-Critical (0.561<2.87).

Table 6: Comparing the Fruit Peel Wax Friction of Scarlet Oak at 15° Angle using Kruskal-Wallis Test

Degrees of Freedom	H-statistics	H-Critical	p-value	Interpretation	Decision
3	1.709	3	0.653	Not Significant	Do not Reject H_o

Table 6 shows the Kruskal-Wallis test of the four peels in terms of friction on the scarlet oak at 15° angle. The table connotes that the degree of freedom is at level 3, while the H-statistics is (1.709), with a H-Critical of 3. Moreover, this is considered as statistically not significant since it exceeds 0.05 (0.635>0.05).

Table 7: Comparison of Fruit Peel Floor Wax Friction on Wood Flooring at 25° Angle using One-Way Analysis Variance

Group	Mean (lux)	Standard Deviation	F-Computed	F-Critical	p-value	Interpretation	Decision
Mango	0.6430	0.09334	2.211	2.87	0.104	Not Significant	Do Not Reject Ho
Papaya	0.6800	0.05735					
Lemon	0.6070	0.05250					
Combined	0.6250	0.05318					

Table 7 shows the mean level of friction of the mango, papaya, lemon, and combined peels in the wood flooring at 25° angle. As shown above, the papaya has the highest mean level of friction, 0.680 seconds, with a standard deviation of 0.057. In comparison, the lowest mean level is lemon with 0.607 seconds with a standard deviation of 0.052. Moreover, the p-value is greater than the level of significance (0.104>0.05), and the F-Computed is less than the F-Critical (2.21<2.87).

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Table 8: Comparing the Fruit Peel Wax Friction of Wood Flooring at 15° Angle using Kruskal-Wallis Test

Degrees of Freedom	H-statistics	H-Critical	p-value	Interpretation	Decision
3	3.897	3	0.273	Not Significant	Do not Reject H_o

Table 8 shows the Kruskal-Wallis test of the four peels in terms of friction on the wood flooring at 15° angle. The table indicates that the degree of freedom is at level 3, while the H-statistics is (3.897), with a H-Critical of 3. Moreover, this is considered as statistically not significant since it is greater than 0.05 (0.273>0.05).

Table 9: Comparing the Shininess of Ceramic Tile using Kruskal-Wallis Test

Degrees of Freedom	H-statistics	H-Critical	p-value	Interpretation	Decision
3	34.454	3	0.000	Significant	Reject H_o

Table 9 shows the Kruskal-Wallis test of the four peels in terms of shininess on the ceramic tile. The table above shows that the degree of freedom is at level 3, while the H-statistics is (34.454), with a H-Critical of 3. Moreover, this is considered as statistically significant since it is less than 0.05 (0.000<0.05).

Table 10: Pairwise Comparison of Means of Fruit Peel Wax on Shininess of Ceramic Tiles

Sample 1-Sample 2	Standard Error	H-Statistic	p-value	Interpretation
Combined-Papaya	5.226	1.225	1.000	Not Significant
Combined-Lemon	5.226	3.483	0.003	Significant
Combined-Mango	5.226	5.396	0.000	Significant
Papaya-Lemon	5.226	-2.258	0.144	Not Significant
Papaya-Mango	5.226	4.172	0.000	Significant
Lemon-Mango	5.226	1.914	0.334	Not Significant

Table 10 shows the pairwise comparison of the means of fruit peels in terms of shininess on ceramic tile. The table above shows that the combined-mango pair has the highest H-statistic (5.396). Conversely, the papaya-lemon pair has the lowest H-statistic (-2.258). Furthermore, combined-lemon, combined-mango, and papaya-lemon pairs are considered statistically significant since their p-value is lower than 0.05 and statistically not significant if their p-value is greater than 0.05.

Table 11: Comparison of Fruit Peel Floor Wax on Shininess of Scarlet Oak using One-Way Analysis Variance

Group	Mean (lux)	Standard Deviation	F-Computed	F-Critical	p-value	Interpretation	Decision
Mango	5.9500	0.49396	3.333	2.87	0.03	Significant	Reject H_o
Papaya	5.2900	0.44833					
Lemon	5.5200	0.64083					
Combined	5.4000	0.22608					

Table 11 shows the mean level of shininess of the mango, papaya, lemon, and the combined peels on scarlet oak. As shown above, the mango has the highest mean level of shininess of 5.950 lux with a standard deviation of 0.493, while the lowest mean level is papaya with 5.290 lux with the standard deviation of 0.448. Moreover, the p-value is less than the level of significance (0.03<0.05), and the F-Computed is greater than the F-Critical (3.33>2.87).

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Table 12: Multiple Comparison of Means of Fruit Peel Floor Wax on the Shininess of Scarlet Oak

Variables	Mean Difference	Standard Error	p-value	Interpretation
Mango-Papaya	0.63000	0.21293	0.005	Significant
Mango-Lemon	0.40000	0.21293	0.068	Not Significant
Mango-Combined	0.52000	0.21293	0.020	Significant
Papaya-Lemon	-0.23000	0.21293	0.287	Not Significant
Papaya-Combined	-0.11000	0.21293	0.609	Not significant
Lemon-Combined	0.12000	0.21293	0.577	Not significant

Table 12 shows the multiple comparisons of means of the four peels in terms of shininess in Scarlet Oak. The table shows that the mango-papaya pair has the highest mean difference (0.630), while the papaya-lemon pair has the lowest mean difference (-0.230). Furthermore, the mango-papaya p-value is considered statistically significant since it is lower than 0.05 (0.005<0.05). On the other hand, mango-combined has a significant difference since the p-value is lower than 0.05. (0.020<0.05).

Table 13: Comparison of Fruit Peel Floor Wax Shininess on Wood Flooring using Analysis Variance

Group	Mean (lux)	Standard Deviation	F-Computed	F-Critical	p-value	Interpretation	Decision
Mango	4.1800	0.25734	1.508	2.87	0.229	Not Significant	Do not Reject H_o
Papaya	4.2000	0.25820					
Lemon	3.9500	0.33747					
Combined	4.1200	0.30840					

Table 13 shows the mean level of shininess of the mango, papaya, lemon, and the combined peels of Wood Flooring. As shown above, papaya has the highest mean level of shininess of 4.200 lux with a standard deviation of 0.258, while the lowest mean level is lemon with 3.950 lux with a standard deviation of 0.337. Moreover, the p-value is greater than the level of significance (0.229>0.05), and the F-Computed is less than the F-Critical (1.508<2.87).

Table 14: Comparing the Fruit Peel Wax Odor using Kruskal-Wallis Test

Degrees of Freedom	H-statistics	H-Critical	p-value	Interpretation	Decision
3	116.931	3	0.000	Significant	Reject H_o

Table 14 shows the Kruskal-Wallis test of the four peels in terms of odor. The table conveys that the degree of freedom is at level 3, while the H-statistics is (116.931), with a H-Critical of 3. Moreover, this is considered as statistically significant since it is less than 0.05 (0.000<0.05).

Table 15: Pairwise Comparison of Means of Fruit Peel Wax on the Odor using Kruskal-Wallis Test

Sample 1-Sample 2	Standard Error	H-Statistic	p-value	Interpretation
Papaya-Mango	11.250	4.425	0.000	Significant
Papaya-Lemon	11.250	-8.512	0.000	Significant
Papaya-Combined	11.250	-9.755	0.000	Significant
Mango-Lemon	11.250	-4.087	0.000	Significant
Mango-Combined	11.250	-5.330	0.000	Significant
Lemon-Combined	11.250	-1.243	1.000	Not Significant

Table 15 shows the pairwise comparison of means of the fruit peels in terms of odor. The table above shows that the papaya-mango pair has the highest H-statistic (4.425). On the contrary, the papaya-combined pair has the lowest H-statistic (-9.755). Moreover, lemon-combined pair is considered statistically not significant since its p-value is greater than 0.05. Other pairs are statistically significant if its p-value is lower than 0.05.

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Table 16: Water Resistance Test

Water Resistance Test				
	Mango	Papaya	Lemon	Combined
Ceramic Tile	5- No Watermark	5- No Watermark	5- No Watermark	5- No Watermark
Scarlet Oak	5- No Watermark	5- No Watermark	5- No Watermark	5- No Watermark
Wooden Flooring	5- No Watermark	5- No Watermark	5- No Watermark	5- No Watermark

Based on the table above, the data shows that there is no comparable difference between the observed marks on the different tiles in conducting the Water Resistance Test.

Table 17: The Average and Standard Deviation Value of Antimicrobial Testing

Crude extract	Zone of Inhibition (mm)			
	Trial 1	Trial 2	Trial 3	Average ±Standard Deviation
Mango	10.82^{b}	11.20^{b}	18.76^{c}	13.59±4.48
Papaya	9.50^{a}	12.50^{b}	11.98^{b}	11.33±1.60
Lemon	10.34^{b}	11.10^{b}	9.66^{a}	10.37±0.72
Combined (Mango, Papaya, and Lemon)	10.04^{b}	9.00^{a}	11.00^{b}	10.01±1.00

Note: Superscripts on the Values Categorize the Resulting Inhibition Activity.
a- no inhibition, b- weak inhibition, c- moderate inhibition.

The data table of 17 evaluated the antimicrobial activity of crude mango, papaya, and lemon extracts, separately and combined. Mango extract has the highest average inhibition zone at 13.59 mm, with (± 4.48 mm) as its standard deviation. On the other hand, papaya extract demonstrated an average zone of inhibition of 11.33 mm with a standard deviation of ±1.60 mm. Moreover, lemon extract shows an average zone of 10.37 mm and low variability (±0.72 mm). The combined extract resulted in an average of 10.01 mm with a variability of (±1.00 mm).

According to Atef, N.M. et al. (2019), Strong Inhibition: Zones of Inhibition (≥ 20 mm), Moderate Inhibition: Zones of Inhibition between 15 and 19 mm, Weak Inhibition: Zones of Inhibition between 10 and 14 mm, and No Inhibition: Zones of Inhibition (≤ 9 mm). The data of mango, papaya, and lemon crude extracts, separately and in combination, reveals varying antimicrobial activity across three trials. The mango extract generally exhibits weak inhibition, ranging from 10.82 mm to 11.2 mm in two trials, but shows moderate inhibition with a notably higher zone of 18.76 mm in the third trial. Papaya extract demonstrates variability, with zones of inhibition ranging from 9.5 mm to 12.5 mm, showing weak inhibition in two trials and no inhibition in the third trial. Lastly, the lemon extract accumulated an inhibition ranging from 9.66 mm to 11.10 mm. The combined peels (mango, papaya, and lemon) extract collectively displays weak inhibition, with inhibition zones ranging from 9 mm to 11 mm across trials.

The data suggests that all the crude extracts—mango, papaya, and lemon—exhibit weak inhibition against the tested microorganisms. Despite variations in their average zone of inhibition, ranging from 10.01 mm to 13.59 mm, none of the extracts show strong antimicrobial activity. Even when combined, the inhibitory effect remains weak, with an average zone of inhibition of 10.01 mm. Therefore, while these extracts may have some antimicrobial properties, they are not highly effective against the microorganisms tested in this study.

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CHAPTER FIVE
CONCLUSIONS AND RECOMMENDATION

A. Summary of Findings

The study examined the friction, odor, and shininess levels of mango, papaya, lemon, and combined fruit peels as floor wax across different surfaces and angles. Lemon peels showed the highest friction on ceramic tile, with a mean level of 0.634 seconds and a standard deviation 0.082, while papaya peels showed the highest friction on wood flooring, with a mean level of 0.680 seconds and a standard deviation of 0.057. Additionally, significant differences in odor were found, particularly with the papaya-mango pair having the highest test statistic (49.780) and the papaya-combined pair having the lowest test statistic (-109.740). However, the lemon-combined pair is not statistically significant, as its p-value exceeded 0.05, contrasting with other pairs where the p-value was lower than 0.05. Mango peels showed the highest shininess on Scarlet Oak, with a mean level of 5.950 lux and a standard deviation of 0.493, while papaya peels showed the highest shininess on wood flooring, with a mean level of 4.200 lux and a standard deviation of 0.258, although these differences were not statistically significant. Significant differences were observed mainly in ceramic tile involving lemon, with pairs such as combined-lemon and mango-lemon showing statistically differences. Water resistance tests indicated that there is no significant difference between the observed marks on the different tiles. Significant differences were primarily in comparisons involving lemon on ceramic tile and mango on scarlet oak for shininess. However, friction comparisons across surfaces and angles generally did not produce significant differences. The antimicrobial testing showed that mango extract displayed the highest average inhibition zone at 13.59 mm. Papaya extract had an average zone of 11.33 mm, while lemon extract showed an average zone of 10.37 mm. Combining the extracts resulted in an average inhibition zone of 10.01 mm, indicating lowest average inhibition zone. According to the parameters, the fruit peels, mango, papaya, lemon, and combined, indicate weak inhibition.

B. Conclusions

In conclusion, this study aimed to assess the effectiveness of *Mangifera indica* (mango), *Carica papaya* (papaya), and *Citrus limon* (lemon) peels, both individually and combined, as alternatives to traditional commercial floor wax. The findings indicate significant differences in performance over different surfaces. Mango peel significantly showed the highest mean level of shininess on scarlet oak, which implies that it is the most effective, while papaya is the most effective on wood flooring. The combined peels showed strong results on ceramic tiles. In terms of friction, lemon peel performed best on ceramic tiles and papaya on wood flooring. These differences highlight the potential of fruit peel-based floor wax as an alternative, though effectiveness varies by flooring type. Water resistance test revealed no significant difference in observed marks on different tiles, indicating consistent performance across surfaces. The antimicrobial testing showed that all crude extracts mango, papaya, and lemon, exhibited weak inhibition against tested microorganisms, with none showing strong antimicrobial activity. Further research is recommended to develop formulations for broader applications.

C. Limitations

The limitations of this study include the dependence on personal perceptions, especially in odor testing, which can differ among individuals. Conducting the study in laboratory settings may not fully reflect everyday conditions, as factors like humidity and temperature could behave differently in household environments where the fruit peel-based floor wax would be used. Additionally, focusing on classrooms in the Philippines may limit the applicability of the findings to other environments or communities. The use of self-conducted testing methods, particularly using a wide-range light meter for shininess testing, may not be affordable or accessible for all potential users, which could affect the feasibility of repeating the study. Despite these challenges, the study's systematic approach provides valuable insights into the potential of fruit peel-based floor wax as an eco-friendly alternative to traditional ones, setting the moment for further research and practical applications.

D. Recommendations

The following recommendations are offered for related research and practical applications:

For Industry Stakeholders, collaborate and promote the fruit peel-based floor wax as alternative to encourage broader adoption and contribute to long-term ecological sustainability.

For Future Researchers, the study's findings suggest the need for more trials to validate the performance of fruit peel-based floor wax across different environmental conditions. Providing two or three more angles for the friction testing will be significantly improve the reliability of the data analysis. Furthermore, it is recommended to develop cost-effective and simplified testing procedures that do not require expensive equipment like wide-range light meters, making the research more accessible and reproducible. Additionally, to guarantee consistency and reliability in evaluating friction, shininess, and other properties, standardized testing protocols for floor wax should be implemented for more accurate results and meaningful comparisons.

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These recommendations aim to enhance the understanding and application of fruit peel-based floor wax, ensuring its practical viability and promoting its environmental benefits various settings to gain insightful pf the bio-floor wax effectiveness and durability. This can serve as a guide for potential consumers to understand the practical benefits of fruit peel-based floor wax.

The study's findings suggest the need for more trials to validate the performance of fruit peel-based floor wax across different environmental conditions. Field experiments conducted in other households and commercial spaces would offer valuable insights into the product's effectiveness and durability in practical applications. To enhance the accessibility of the testing methods, it would be beneficial to develop cost-effective and simplified testing procedures that do not require expensive equipment like wide-range light meter. Collaborating with industry stakeholders, including manufacturers and environmental agencies, could facilitate the development and promotion of eco-friendly floor wax alternatives, encouraging broader adoption and long-term ecological sustainability. To guarantee consistency and reliability in evaluating friction, shininess, and other properties, standardized testing protocols for floor wax should be implemented for more accurate results and meaningful comparisons.

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APPENDICES

APPENDIX 1
MATERIALS AND INSTRUMENTS


Electric Blender


Drying Oven



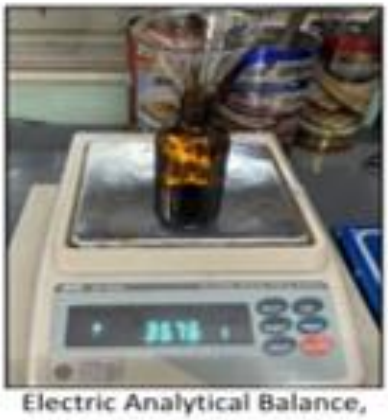
60 Mesh 0.3mm Aperture Lab Standard Test Sieve


Rotary Evaporator


Incubator


Fruit Peels (Mango, Papaya, and Lemon)


Petri Dish & Vernier Caliper


Electric Analytical Balance, Glass Bottle (Extract), & Glass Funnel


Different Reagent Bottles Sizes, Foil, & Whatman Filter Paper No.1

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APPENDIX 2
CORRESPONDENCE

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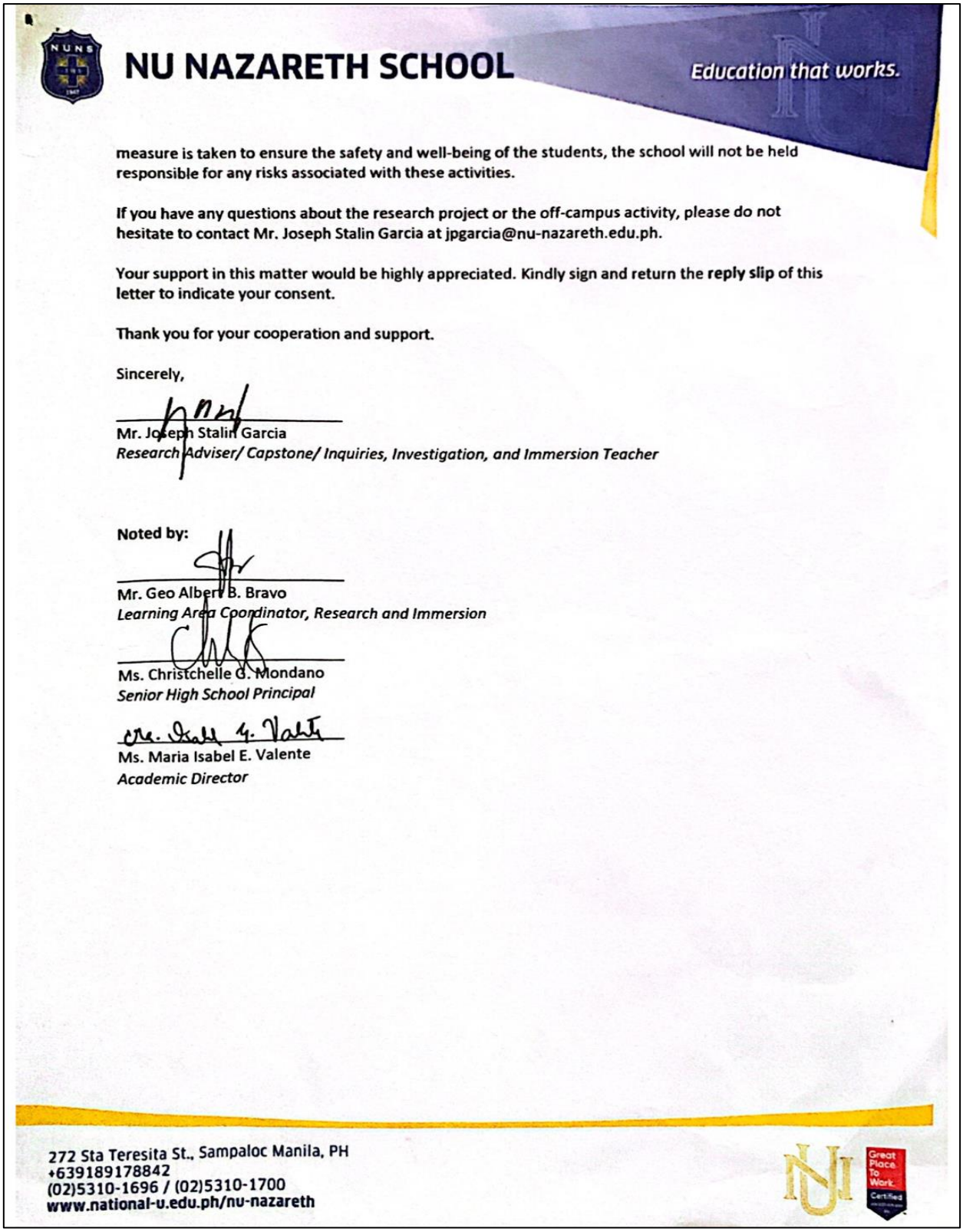
APPENDIX 3
CERTIFICATION OF ORIGINALITY CHECK



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measure is taken to ensure the safety and well-being of the students, the school will not be held responsible for any risks associated with these activities.

If you have any questions about the research project or the off-campus activity, please do not hesitate to contact Mr. Joseph Stalin Garcia at jpgarcia@nu-nazareth.edu.ph.

Your support in this matter would be highly appreciated. Kindly sign and return the **reply slip** of this letter to indicate your consent.

Thank you for your cooperation and support.

Sincerely,

Mr. Joseph Stalin Garcia
Research Adviser/ Capstone/ Inquiries, Investigation, and Immersion Teacher

Noted by:

Mr. Geo Albert B. Bravo
Learning Area Coordinator, Research and Immersion

Ms. Christchelle G. Mondano
Senior High School Principal

Ms. Maria Isabel E. Valente
Academic Director

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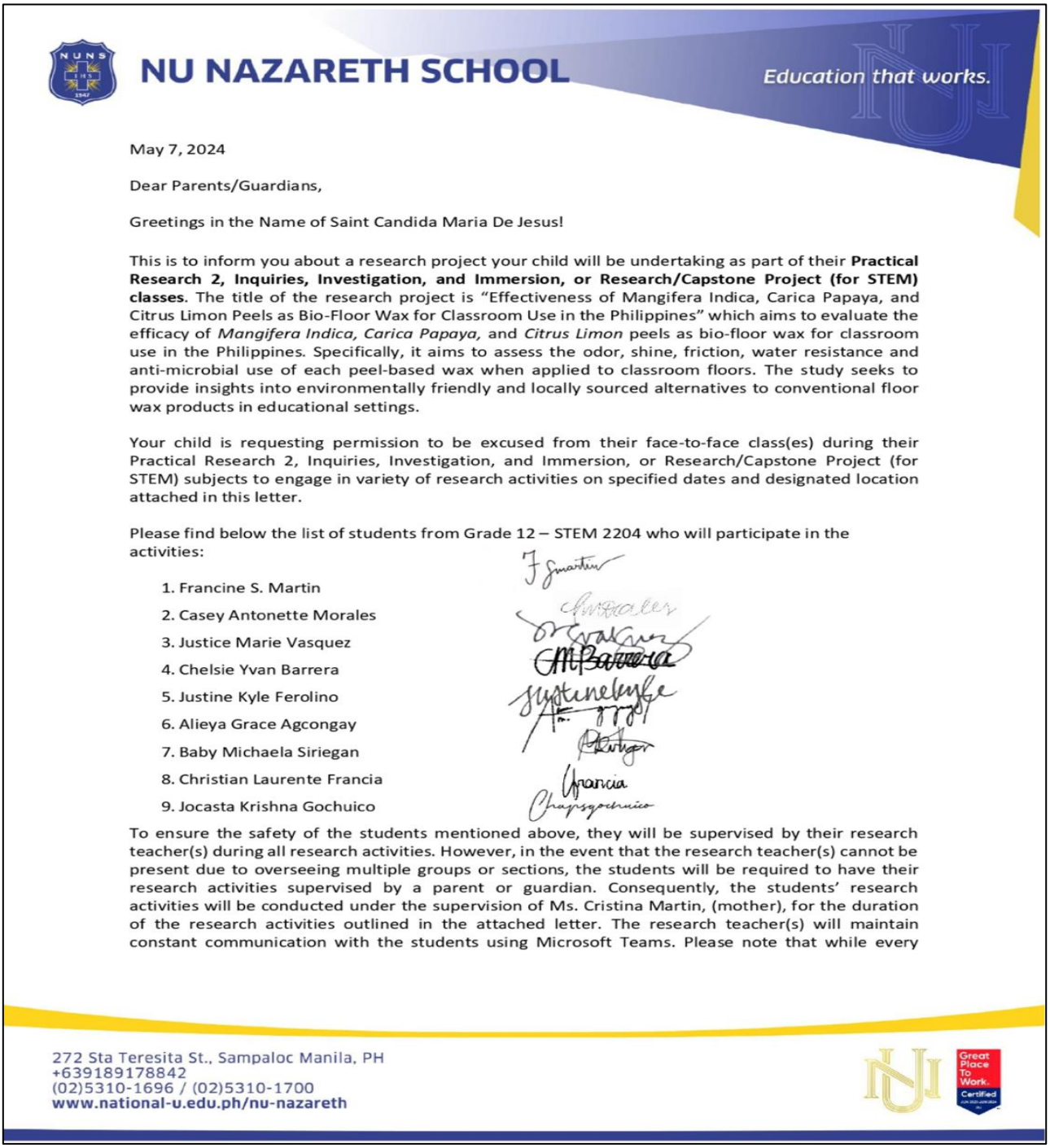
APPENDIX 4
INFORMED CONSENT FORM

➢ *Permission to Conduct the Experiment Outside*



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May 7, 2024

Dear Parents/Guardians,

Greetings in the Name of Saint Candida Maria De Jesus!

This is to inform you about a research project your child will be undertaking as part of their **Practical Research 2, Inquiries, Investigation, and Immersion, or Research/Capstone Project (for STEM) classes**. The title of the research project is "Effectiveness of Mangifera Indica, Carica Papaya, and Citrus Limon Peels as Bio-Floor Wax for Classroom Use in the Philippines" which aims to evaluate the efficacy of *Mangifera Indica, Carica Papaya,* and *Citrus Limon* peels as bio-floor wax for classroom use in the Philippines. Specifically, it aims to assess the odor, shine, friction, water resistance and anti-microbial use of each peel-based wax when applied to classroom floors. The study seeks to provide insights into environmentally friendly and locally sourced alternatives to conventional floor wax products in educational settings.

Your child is requesting permission to be excused from their face-to-face class(es) during their Practical Research 2, Inquiries, Investigation, and Immersion, or Research/Capstone Project (for STEM) subjects to engage in variety of research activities on specified dates and designated location attached in this letter.

Please find below the list of students from Grade 12 – STEM 2204 who will participate in the activities:

1. Francine S. Martin
2. Casey Antonette Morales
3. Justice Marie Vasquez
4. Chelsie Yvan Barrera
5. Justine Kyle Ferolino
6. Alieya Grace Agcongay
7. Baby Michaela Siriegan
8. Christian Laurente Francia
9. Jocasta Krishna Gochuico

To ensure the safety of the students mentioned above, they will be supervised by their research teacher(s) during all research activities. However, in the event that the research teacher(s) cannot be present due to overseeing multiple groups or sections, the students will be required to have their research activities supervised by a parent or guardian. Consequently, the students' research activities will be conducted under the supervision of Ms. Cristina Martin, (mother), for the duration of the research activities outlined in the attached letter. The research teacher(s) will maintain constant communication with the students using Microsoft Teams. Please note that while every

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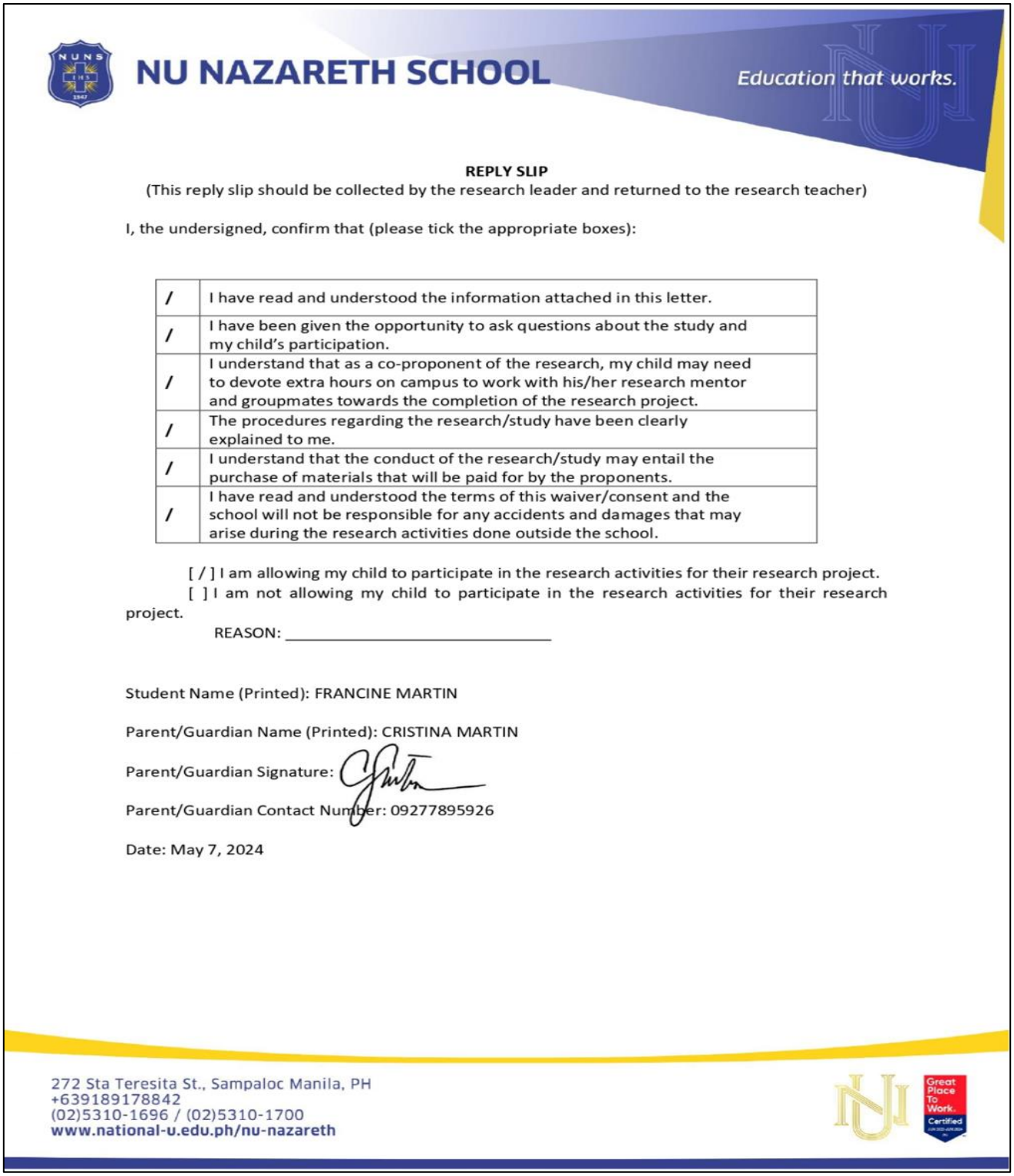
➢ *Reply Slip*



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REPLY SLIP

(This reply slip should be collected by the research leader and returned to the research teacher)

I, the undersigned, confirm that (please tick the appropriate boxes):

/	I have read and understood the information attached in this letter.
/	I have been given the opportunity to ask questions about the study and my child's participation.
/	I understand that as a co-proponent of the research, my child may need to devote extra hours on campus to work with his/her research mentor and groupmates towards the completion of the research project.
/	The procedures regarding the research/study have been clearly explained to me.
/	I understand that the conduct of the research/study may entail the purchase of materials that will be paid for by the proponents.
/	I have read and understood the terms of this waiver/consent and the school will not be responsible for any accidents and damages that may arise during the research activities done outside the school.

[/] I am allowing my child to participate in the research activities for their research project.

[ ] I am not allowing my child to participate in the research activities for their research project.

REASON: _____

Student Name (Printed): FRANCINE MARTIN

Parent/Guardian Name (Printed): CRISTINA MARTIN

Parent/Guardian Signature:

Parent/Guardian Contact Number: 09277895926

Date: May 7, 2024

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[/] I am allowing my child to participate in the research activities for their research project.

[ ] I am not allowing my child to participate in the research activities for their research project.

REASON: _____

Student Name (Printed): CHELSIE BARRERA

Parent/Guardian Name (Printed): CHIQUI BARRERA

Parent/Guardian Signature: 

Parent/Guardian Contact Number: 09466797525

Date: May 7, 2024

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[/] I am allowing my child to participate in the research activities for their research project.

[ ] I am not allowing my child to participate in the research activities for their research project.

REASON: _____

Student Name (Printed): CHRISTIAN LAURENTE FRANCIA

Parent/Guardian Name (Printed): RACHEL FRANCIA

Parent/Guardian Signature:

Parent/Guardian Contact Number: 09173009074

Date: May 7, 2024

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[ ] I am not allowing my child to participate in the research activities for their research project.

REASON: _____

Student Name (Printed): JOCASTA GOCHUICO

Parent/Guardian Name (Printed): EDWARD GOCHUICO

Parent/Guardian Signature: Edward

Parent/Guardian Contact Number: 09761511468

Date: May 7, 2024

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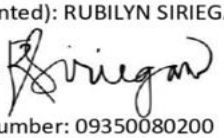
[ ] I am not allowing my child to participate in the research activities for their research project.

REASON: _____

Student Name (Printed): MICHAELA BABY SIRIEGAN

Parent/Guardian Name (Printed): RUBILYN SIRIEGAN

Parent/Guardian Signature: 

Parent/Guardian Contact Number: 09350080200

Date: May 7, 2024

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[/] I am allowing my child to participate in the research activities for their research project.

[ ] I am not allowing my child to participate in the research activities for their research project.

REASON: _____

Student Name (Printed): ALIEYA AGCONGAY

Parent/Guardian Name (Printed): LENIE AGCONGAY

Parent/Guardian Signature:

Parent/Guardian Contact Number: 09176506342

Date: May 7, 2024

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[ ] I am not allowing my child to participate in the research activities for their research project.

REASON: _____

-

Student Name (Printed): CASEY MORALES

Parent/Guardian Name (Printed): CRISTINA MORALES

Parent/Guardian Signature:

Parent/Guardian Contact Number: 09288670230

Date: May 7, 2024

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[/] I am allowing my child to participate in the research activities for their research project.

[ ] I am not allowing my child to participate in the research activities for their research project.

REASON: _____

Student Name (Printed): JUSTINE KYLE FEROLINO

Parent/Guardian Name (Printed): SHERLITA GURAY

Parent/Guardian Signature:

Parent/Guardian Contact Number: 09288670230

Date: May 7, 2024

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[ ] I am not allowing my child to participate in the research activities for their research project.

REASON: _____

Student Name (Printed): JUSTICE VASQUEZ

Parent/Guardian Name (Printed): MARIVEL VASQUEZ

Parent/Guardian Signature:

Parent/Guardian Contact Number: 09153496353

Date: May 7, 2024

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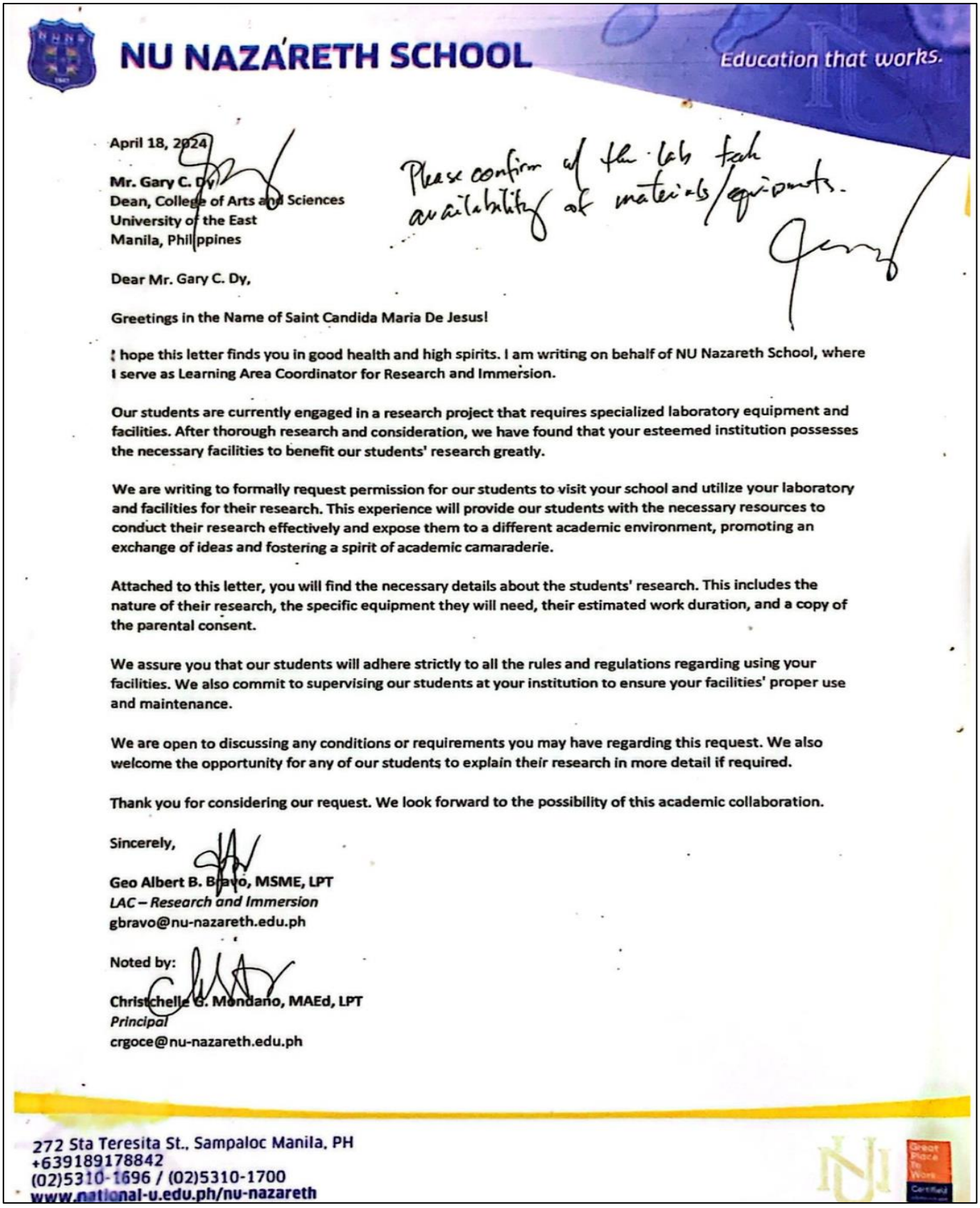
➢ *Letter Permission for University of the East*



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April 18, 2024

Please confirm of the lab tech availability of materials/equipments.

Mr. Gary C. Dy
Dean, College of Arts and Sciences
University of the East
Manila, Philippines

Dear Mr. Gary C. Dy,

Greetings in the Name of Saint Candida Maria De Jesus!

I hope this letter finds you in good health and high spirits. I am writing on behalf of NU Nazareth School, where I serve as Learning Area Coordinator for Research and Immersion.

Our students are currently engaged in a research project that requires specialized laboratory equipment and facilities. After thorough research and consideration, we have found that your esteemed institution possesses the necessary facilities to benefit our students' research greatly.

We are writing to formally request permission for our students to visit your school and utilize your laboratory and facilities for their research. This experience will provide our students with the necessary resources to conduct their research effectively and expose them to a different academic environment, promoting an exchange of ideas and fostering a spirit of academic camaraderie.

Attached to this letter, you will find the necessary details about the students' research. This includes the nature of their research, the specific equipment they will need, their estimated work duration, and a copy of the parental consent.

We assure you that our students will adhere strictly to all the rules and regulations regarding using your facilities. We also commit to supervising our students at your institution to ensure your facilities' proper use and maintenance.

We are open to discussing any conditions or requirements you may have regarding this request. We also welcome the opportunity for any of our students to explain their research in more detail if required.

Thank you for considering our request. We look forward to the possibility of this academic collaboration.

Sincerely,

Geo Albert B. Bravo, MSME, LPT
LAC – Research and Immersion
gbravo@nu-nazareth.edu.ph

Noted by:

Christchelle G. Mondano, MAEd, LPT
Principal
crgoce@nu-nazareth.edu.ph

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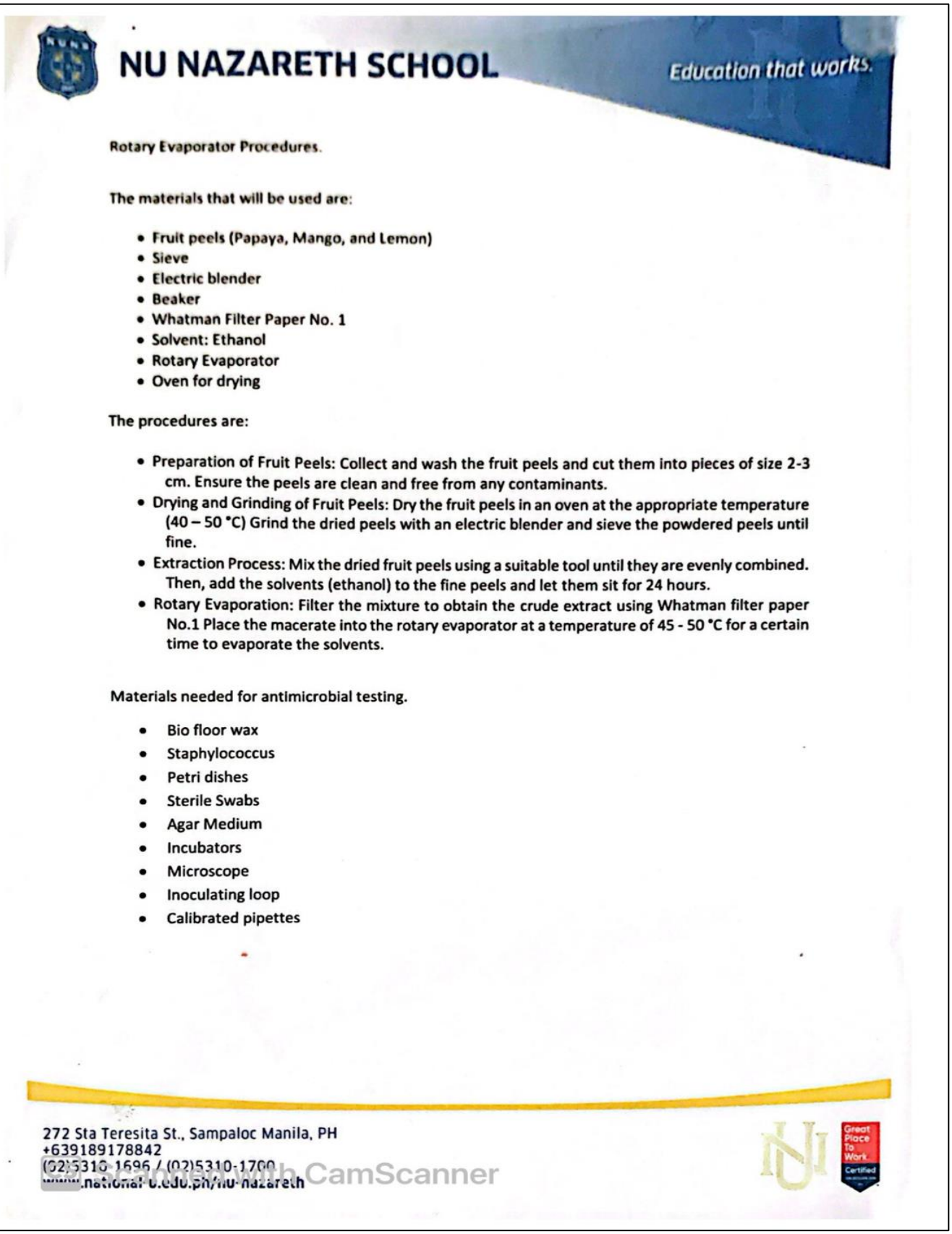

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Rotary Evaporator Procedures.

The materials that will be used are:

- Fruit peels (Papaya, Mango, and Lemon)
- Sieve
- Electric blender
- Beaker
- Whatman Filter Paper No. 1
- Solvent: Ethanol
- Rotary Evaporator
- Oven for drying

The procedures are:

- Preparation of Fruit Peels: Collect and wash the fruit peels and cut them into pieces of size 2-3 cm. Ensure the peels are clean and free from any contaminants.
- Drying and Grinding of Fruit Peels: Dry the fruit peels in an oven at the appropriate temperature (40 – 50 °C) Grind the dried peels with an electric blender and sieve the powdered peels until fine.
- Extraction Process: Mix the dried fruit peels using a suitable tool until they are evenly combined. Then, add the solvents (ethanol) to the fine peels and let them sit for 24 hours.
- Rotary Evaporation: Filter the mixture to obtain the crude extract using Whatman filter paper No.1 Place the macerate into the rotary evaporator at a temperature of 45 - 50 °C for a certain time to evaporate the solvents.

Materials needed for antimicrobial testing.

- Bio floor wax
- Staphylococcus
- Petri dishes
- Sterile Swabs
- Agar Medium
- Incubators
- Microscope
- Inoculating loop
- Calibrated pipettes

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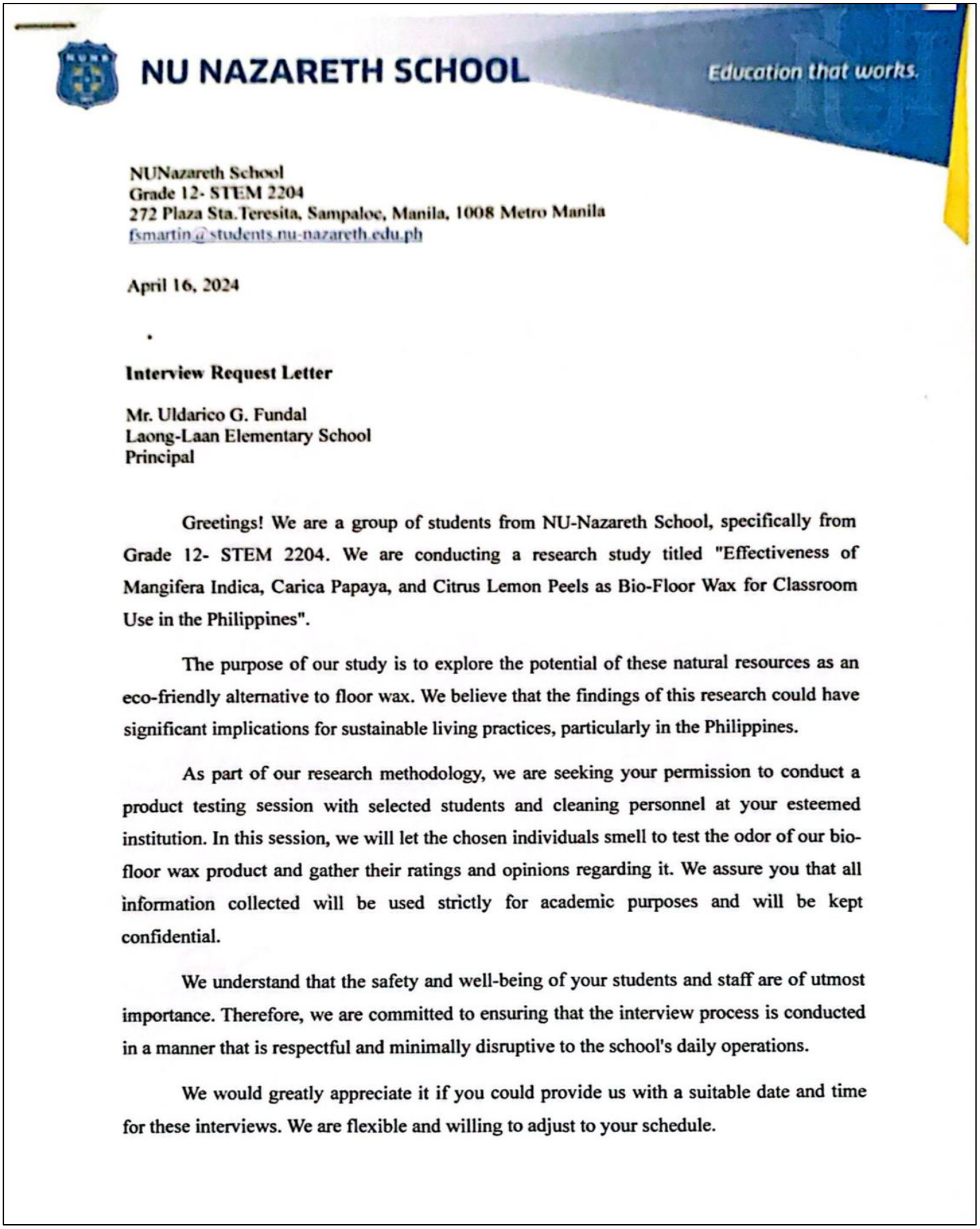
➢ *Survey Request Letter*



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NUNazareth School
Grade 12- STEM 2204
272 Plaza Sta.Teresita, Sampaloc, Manila, 1008 Metro Manila
fsmartin@students.nu-nazareth.edu.ph

April 16, 2024

Interview Request Letter

Mr. Uldarico G. Fundal
Laong-Laan Elementary School
Principal

Greetings! We are a group of students from NU-Nazareth School, specifically from Grade 12- STEM 2204. We are conducting a research study titled "Effectiveness of Mangifera Indica, Carica Papaya, and Citrus Lemon Peels as Bio-Floor Wax for Classroom Use in the Philippines".

The purpose of our study is to explore the potential of these natural resources as an eco-friendly alternative to floor wax. We believe that the findings of this research could have significant implications for sustainable living practices, particularly in the Philippines.

As part of our research methodology, we are seeking your permission to conduct a product testing session with selected students and cleaning personnel at your esteemed institution. In this session, we will let the chosen individuals smell to test the odor of our bio-floor wax product and gather their ratings and opinions regarding it. We assure you that all information collected will be used strictly for academic purposes and will be kept confidential.

We understand that the safety and well-being of your students and staff are of utmost importance. Therefore, we are committed to ensuring that the interview process is conducted in a manner that is respectful and minimally disruptive to the school's daily operations.

We would greatly appreciate it if you could provide us with a suitable date and time for these interviews. We are flexible and willing to adjust to your schedule.

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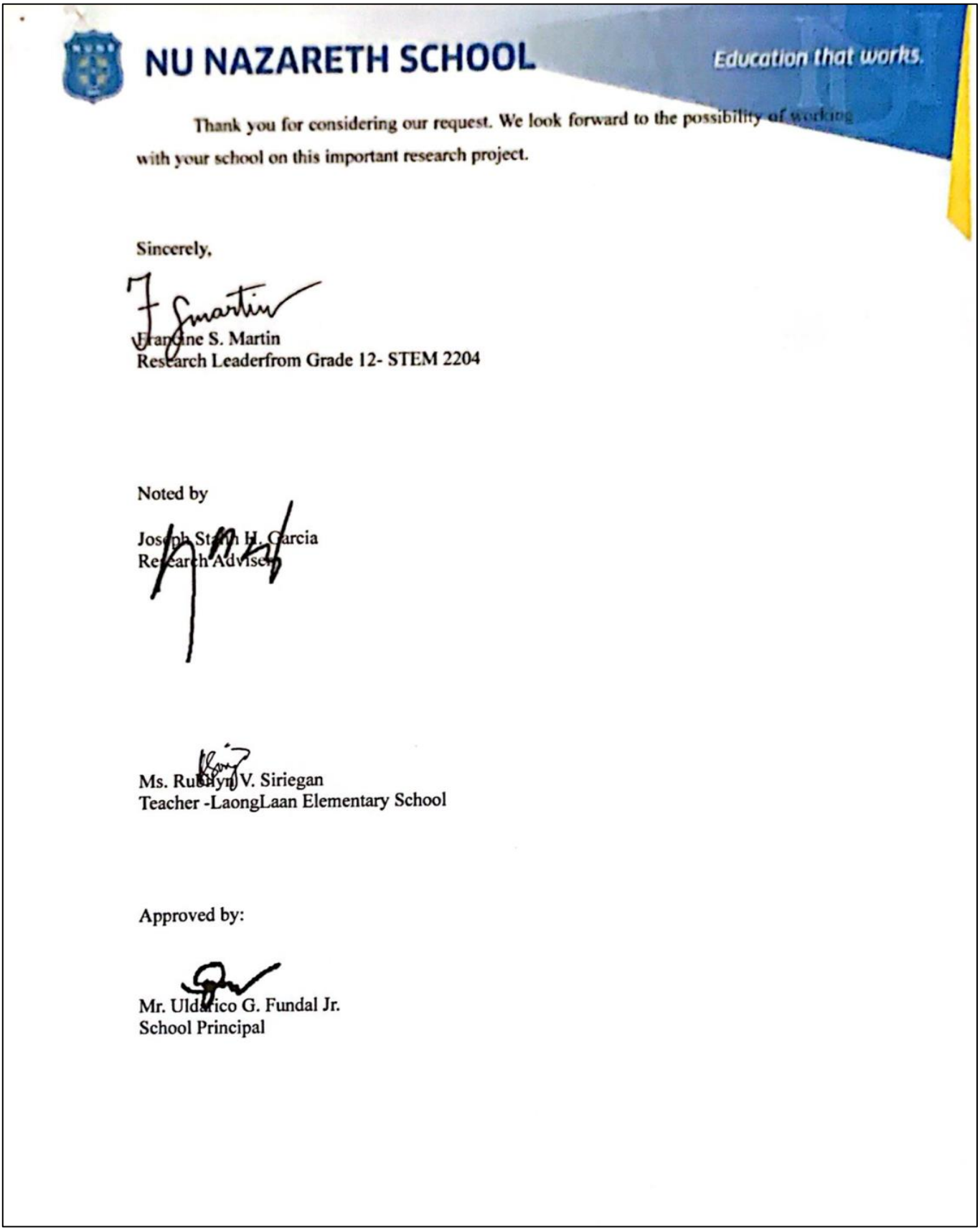

NU NAZARETH SCHOOL

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Thank you for considering our request. We look forward to the possibility of working with your school on this important research project.

Sincerely,

Francine S. Martin
Research Leaderfrom Grade 12- STEM 2204

Noted by

Joseph Stalin H. Garcia
Research Adviser

Ms. Ruthyn V. Siriegan
Teacher -LaongLaan Elementary School

Approved by:

Mr. Uldarico G. Fundal Jr.
School Principal