Management System ISO 9001:2015
www.tuv.com ID 9000018803

ROMBLON STATE UNIVERSITY

RESEARCH JOURNAL

ISSN 2350-8183 (Print)
ISSN 2619-7529 (Online)
Volume 5 No. 2, 2023

https://ojs.rsu.edu.ph redi.publication@rsu.edu.ph

ABOUT THE JOURNAL

Romblon State University Research Journal is a refereed multi-disciplinary research journal that aims to provide a source of information in the areas of agriculture, natural resources and environment; social science, ethics, humanities and the arts; physical and biological sciences; business and management; engineering, information and communication technology; education; health and medical education; alternative medicine; institutional system and process assessment; and community baseline or impact studies. The objective of the journal is to help educators and decision-makers disseminate information and learn from each other's work.

ROMBLON STATE UNIVERSITY
RESEARCH JOURNAL

EDITORIAL TEAM

EXTERNAL EVALUATORS

TECHNICAL REVIEWERS

Merian P. Catajay-Mani, Ed.D., CESE
President, Romblon State University

Tomas T. Faminial, Ph.D.
Vice President for Administration and Finance

Emelyn F. Montoya, Ph.D.
Vice President for Academic Affairs

Atty. Glenn Niño M. Sartillo
Chief Administrative Officer

Virgilio F. Fadera, Ph.D.
Romblon State University – Calatrava Campus

Carlwin V. Dayagdag
Director, Management Information System and Data Protection Officer

Catherine Bhel B. Aguila
Director, Institute of Information and Technology

TABLE OF CONTENTS

Romblon State University Research Journal
ISSN: 2619-7529 (Online) | ISSN: 2350-8183 (Print)
Volume 5 (2): 1-11, 2023

In Situ Synthesis of Bare Silver Nanoparticles on Paper for Copper (II) Ion Detection

Shaira Mae D. Valero, Glenn Rose M. Suelan, Precious B. Babar, Josie Faith N. Calvo, and Francis Eric P. Almaquer

ABSTRACT

This study synthesized bare silver nanoparticles on paper and evaluated its response to copper (Cu (II)) ions to assess its potential as a colorimetric sensing platform. The nanoparticles were synthesized in situ on paper using silver nitrate and sodium borohydride as a precursor and reducing agent, respectively. No stabilizer or functionalizing agent was added. A two-factor three-level full factorial design with varying concentrations of reagents was employed in the synthesis process. The resulting sensor was successfully characterized using diffuse reflectance spectroscopy and scanning electron microscopy with elemental dispersive x-ray spectroscopy. The sensor was exposed to varying Cu (II) concentrations ranging from 1 to 30 mM and the developed color changes were analyzed using computer imaging software. The color changes were quantified using mean gray values from the imaging software. Based on the results, as the concentration of Cu (II) ions increased, the final mean gray value of the paper increased as well. The papers were observed to marginally lighten in color potentially due to the decrease in silver atoms or its interaction with copper. The relationship between Cu (II) concentration and the ratio of final and initial mean gray value was determined and although a weak linear relation existed from 1 to 30 mM, a positive slope supported the increase in mean gray value within the range tested. A change in the elemental composition of the paper sensor confirms lightening after its exposure to Cu (II) ions. The sensor also displayed a selective response towards the Cu (II) among other metals tested.

Keywords: *Copper, in situ, paper-based, sensor, silver nanoparticles*

INTRODUCTION

Copper in trace amounts is important in many human biological functions such as in iron metabolism and being a cofactor of various redox enzymes. However, it is toxic to the body at high concentrations (Bost et al., 2016). Additionally, it is also associated, directly or indirectly, with the pathogenesis of many neurological diseases such as Menkes disease and Wilson disease (Desai & Kaler, 2008).

Detection and measurement of the concentration of copper in different matrices such as in aqueous solution can be performed using powerful analytical methods. Helaluddin et al. (2016) reviewed the different techniques used for elemental analysis such as atomic absorption spectrometry, x-ray fluorescence, and mass spectrometry. These techniques can be employed with good sensitivity and accuracy at the trace level, but they also require high capital costs with instruments involving complex procedures that can only be performed by trained analysts inside established laboratories. Hence, there is a growing body of research dedicated to developing alternative methods for copper detection that are simple, inexpensive, and easy to use.

The development of sensors using nanoparticles has gained wide attention in recent years. Many studies have used silver nanoparticles (AgNP) as colorimetric sensors due to their optical property called localized surface plasmon resonance (LSPR). This refers to the collective oscillation of conducting electrons of the nanoparticles due to electromagnetic radiation. Metallic nanoparticles such as gold and silver nanoparticles exhibit LSPR, thus, they have been used in many research for detecting proteins, organic molecules, and inorganic ions (Vilela et al., 2012).

✉ fpalmaquer@up.edu.ph
School of Technology, University of the Philippines Visayas, Miagao
Received 20 June 2023; Revised 7 December 2023; Accepted 14 December 2023

There are recent studies that focused on the use of AgNPs for copper detection as Cu(II) ions. Most of the research falls under two main categories: solution-based and paper-based colorimetric assays. The solution-based assay detects Cu(II) ions by its interaction with AgNPs in an aqueous solution. Pourreza and Golmohammadi (2014) reported the use of AgNPs in cloud point extraction for the determination of the metal ions. The emerging use of the different stabilizers was also evaluated in the determination of Cu(II) ions such as citrate-stabilized AgNP (Almaquer & Perez, 2019), dopamine-AgNPs (Ma et al., 2011), and the green synthesis of AgNPs using leaf extract (Kirubaharan et al., 2012). Apart from these solution-based studies, paper-based colorimetric sensors have also been developed where paper is used as a substrate for the sensors. Paper is utilized due to its flexibility, absorbency, biocompatibility and biodegradability, ease of production and modification, low cost, and availability (Nery & Kubota, 2013). Fabrication methods of these paper sensors and its colorimetric response with copper were investigated in different studies. The first case used a modified AgNP embedded in a paper-based analytical device to detect Cu(II) in tap and pond water samples (Ratnarathorn et al., 2012). The complex wax screen-printing method to a simple dipping technique of fabricating decorated AgNPs in the paper sensor also brought about the detection of Cu(II) in samples such as in water, food, and blood (Chaiyo et al., 2015; Budlayan et al., 2021). The fabrication of simple and low-cost paper sensors for the detection of copper ions makes it more attractive for point-of-use detection of real-world samples.

This study reports the use of bare AgNP synthesized in situ on paper as a potential platform for detecting Cu(II) ions. The in situ synthesis of the bare AgNP on paper was performed using a factorial design for determining the best combination of reagent concentrations to be used. No functionalizing or stabilizing agent was added in the synthesis method. The resulting paper-based sensor was characterized using diffuse reflectance spectroscopy and scanning electron microscopy coupled with energy dispersive x-ray spectroscopy. Response of the bare AgNP paper-based sensor to Cu(II) was determined through color changes in the paper quantified using its mean gray value determined by image analysis. A selectivity test was conducted to compare the response of the sensor to Cu(II) against other common ions.

METHODOLOGY

Materials

The following chemicals were used in the study: silver nitrate ($AgNO_3$), sodium borohydride ($NaBH_4$), copper sulphate ($CuSO_4$), activated magnesium oxide (MgO), calcium hydroxide ($Ca(OH)_2$), potassium chloride (KCl), barium chloride ($BaCl_2$), and ethanol

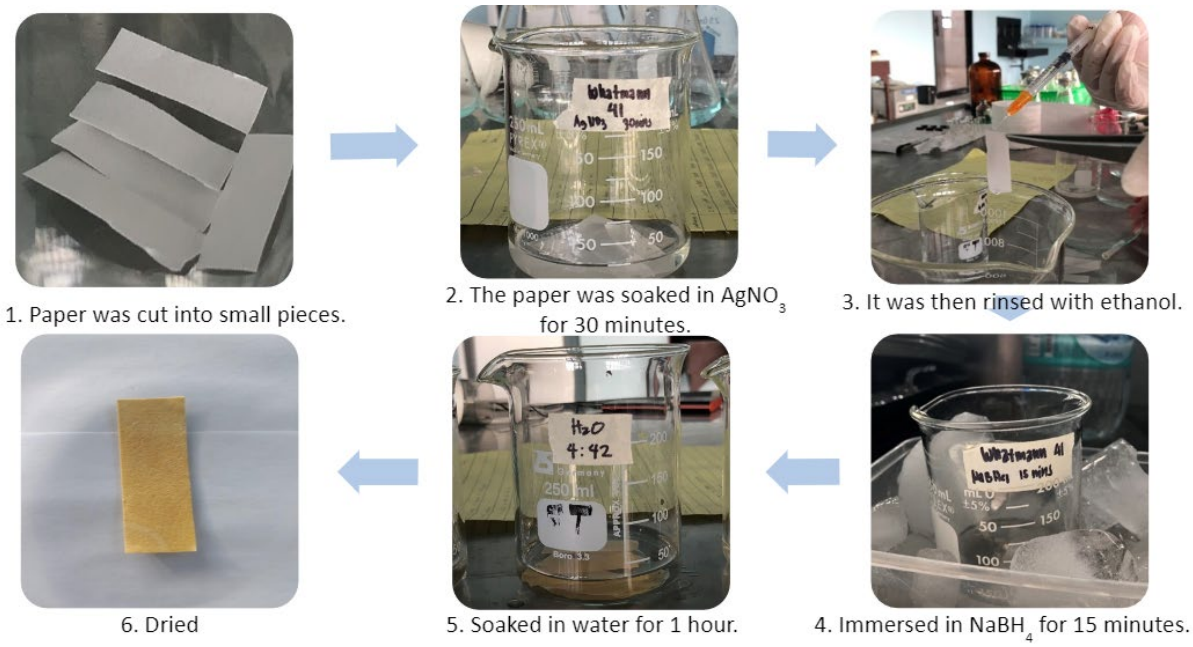


Figure 1. Actual photos showing the steps made for the synthesis of the paper sensor.

(C_2H_5OH). The reagents mentioned were analytical grade and of high purity. Whatman filter paper no. 41 that was used as the paper substrate has a particle retention of 20-25 µm. All aqueous solutions were prepared using distilled water.

Equipment

Digital imaging analysis was performed using ImageJ software. Characterization of the paper sensor was done by Diffuse Reflectance Spectroscope (Cary 5000) and Scanning Electron Microscope (SEM Hitachi SU3500) coupled with Energy Dispersive X-ray Spectroscope (EDS Bruker XFlash 6 | 30).

Fabrication of the Bare-AgNP Paper Sensor

The method for fabricating the bare-AgNP paper sensor was adapted from Dankovich and Gray (2011) and He et al. (2003) with minor modifications. Figure 1 shows the actual photos of the steps made in the synthesis of the paper sensor. Briefly, the Whatman no. 41 filter paper was cut into pieces with dimensions of 1 cm × 4 cm. The paper strips were then soaked for 30 minutes in a beaker with 20 mL of $AgNO_3$ solution. They were then rinsed with pure ethanol to remove excess $AgNO_3$ that was not absorbed into the filter paper. Afterward, the papers were immersed in a 20 mL cold solution of $NaBH_4$ for 15 minutes and then soaked in distilled water for an hour. It was observed that the white filter paper turned yellow-brown immediately after being immersed in $NaBH_4$ solution. The paper sensors were then dried and cut into uniform circles with diameters of 6 mm using a puncher.

Experimental Design

A two-factor three-level (3^2) full factorial experimental design was employed to optimize the concentration of the bare AgNP attached to the paper substrate. The parameters varied were the concentrations of the $AgNO_3$ and $NaBH_4$ which were the precursor metal source and the reducing agent, respectively. The two reagents were identified as the major factors that will influence the silver nanoparticles synthesized in the paper. Determining the appropriate concentrations of $AgNO_3$ and $NaBH_4$ was essential in producing an effective paper sensor. The resulting paper sensors were analyzed using ImageJ, an imaging software tool. Table 1 shows the experimental design employed in the synthesis process including their coded levels.

Table 1. The 3^2 full factorial design employed in the synthesis process.

Factor	Symbol	Values of coded levels		
		-1	0	+1
$AgNO_3$ concentration (mM)	A	1	3	5
$NaBH_4$ concentration (mM)	B	2	6	10

Image Analysis

Image analysis of all samples in the study followed the same procedure. Treated samples were allowed to develop color changes for 10 minutes before image capture for stability. The samples were placed inside a fabricated monitoring box as seen in Figure 2. This is to obtain a uniform and controlled lighting environment for all samples. Photos were taken using a smartphone (Samsung Galaxy J7 Pro) and analyzed using ImageJ software. The presence of AgNP on paper substrate can be checked in the preliminary trials by the yellow-brown color change of the originally white filter paper. The color change is an indication of the formation of AgNP on the paper (Dankovich, 2014). Comparison of the color intensity among different treatments can be done in ImageJ by converting the original images to 32-bit grayscale images and calculating their mean gray value (MGV). Hence, analysis of the image can be performed by calculating and comparing the MGVs of the samples alongside other characterization techniques. The MGV is the reported result of a grayscale image created by taking the minimum value of the three RGB channels for each pixel. This method is used to create a grayscale image that is more sensitive to changes in brightness than the standard RGB image. The comparison of the lightening and darkening of the paper sensor using MGV provides a more accurate representation of the changes in brightness. The same region of interest was analyzed for all samples

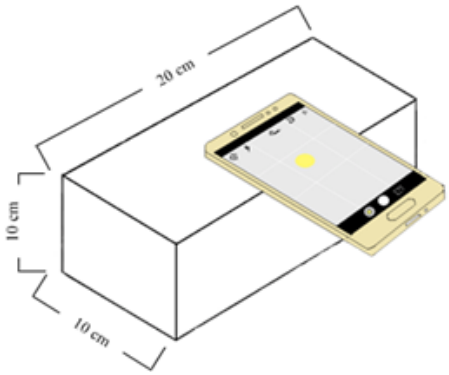


Figure 2. Sketch and measurements of the monitoring box for image capture.

Characterization of the Paper Sensor

Samples of the bare-AgNP paper sensors were sent to the University of the Philippines Visayas Regional Research Center (UPV RRC) for characterization. Diffuse reflectance spectroscopy (DRS) was used to determine the unique surface plasmon peak of the AgNP on paper. SEM analysis was used to determine the morphological difference pre- and post-synthesis of AgNP, as well as following the addition of copper ions. The size of the synthesized AgNP was also identified through the said analysis. Combined with EDS, the different elements present were visually mapped and the semi-quantitative information regarding their weight percentage distribution in the paper was obtained. The data gathered from the three techniques could confirm the presence of AgNP in the sensor.

Colorimetric Response to Cu(II) Ions

Cu(II) Ion Sensing. Different concentrations of Cu(II) from 1, 10, 20, 25 and 30 mM were prepared and dropped onto the bare-AgNP paper sensors. Images of the sensors underwent digital imaging analyses to determine the MGV before and after Cu(II) addition. This is to describe the effect of varying concentrations of Cu(II) on the color of the paper. Additionally, a plot profile of the MGV per paper was generated.

Selectivity Test. The following ions were used: Cu^{2+}, Mg^{2+}, Ca^{2+}, Ba^{2+}, and K^{+}. Different metal cation solutions at 10 mM were dropped onto the paper sensor. Photos were captured and subjected to digital imaging analysis to observe their effect on the paper sensor. Furthermore, the responses of the different ions to the paper sensor were compared quantitatively through their change in MGV.

RESULTS AND DISCUSSION

Synthesis of Bare AgNP on Paper using Factorial Design

Bare AgNPs or AgNPs, without functionalizing or stabilizing agents, were synthesized in situ on paper. During the experiment, the success of the synthesis process was monitored by observing the color change of the filter paper from white to yellow-brown. The color change is due to the unique optical property of AgNP called surface plasmon resonance (SPR) and is an indication of the formation of AgNP on paper (Dankovich, 2014; Swensson et al., 2018). In this study, upon immersion of the $AgNO_3$-wetted paper into the $NaBH_4$ solution, a color change in the paper from white to yellow-brown was immediately observed. The comparison of colors before and after the synthesis process is shown in Figure 3.

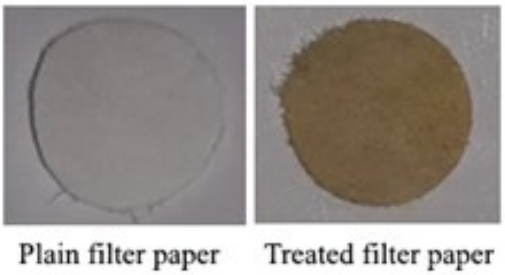


Figure 3. Color change of white Whatman 41 filter paper to brown after the AgNP synthesis process. Treated paper image taken from paper treated with 5 mM $AgNO_3$ and 6 mM $NaBH_4$.

In terms of AgNP formation, the $AgNO_3$ served as the silver source, and upon immersion of the $AgNO_3$-wetted paper to the reducing agent $NaBH_4$ solution, ionic silver is reduced to silver zero following the chemical equation presented by Mulfinger et al. (2007):

$$AgNO_3 + NaBH_4 \rightarrow Ag + \tfrac{1}{2}H_2 + \tfrac{1}{2}B_2H_6 + NaNO_3 \quad (1)$$

The aggregation of Ag results in the formation of AgNP. These monodispersed AgNP appear yellow in solution due to their SPR. Moreover, they also exhibit the same yellow-brown color on paper as reported by other similar studies mentioned earlier (Dankovich, 2014; Swensson et al., 2018). It can be noted that the $AgNO_3$, $NaBH_4$, and ethanol solutions used as reagents in the synthesis process are colorless solutions.

Different factors affect the morphologies and structure in the synthesis of AgNPs in solutions, such as the concentration of reducing agent, the effect of the surfactants and polymers, temperature, $AgNO_3$ concentration, and the molar ratio of silver precursor and stabilizing agent (Li et al., 2009; AL-Thabaiti et al., 2008; Khodashenas & Ghorbani, 2014). In this study, the AgNPs were synthesized in situ on paper. The concentrations of the precursor and reducing agents as the independent variables were investigated. The synthesis process was subsequently performed using a two-factor three-level (3^2) full factorial experimental design varying the concentration of $AgNO_3$ (precursor agent) and $NaBH_4$ (reducing agent). This was done to determine the best synthesis treatment moving forward with the experiment and to determine both the significance of the factors and their interaction. The response parameter is the MGV of the paper sensor which measures the color intensity of the paper. The

Romblon State University Research Journal
ISSN: 2619-7529 (Online) | ISSN: 2350-8183 (Print)
Volume 5 (2): 1-11, 2023

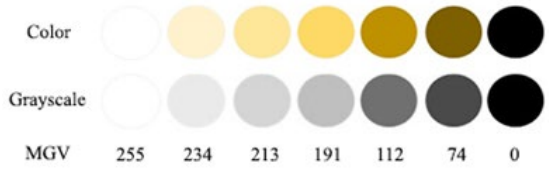


Figure 4. Sample shades of yellow brown converted to 32-bit grayscale image with equivalent MGV.

MGV correlates to the AgNP content of the samples. Several studies have already shown that the formation of AgNP on paper results in the yellow-brown appearance of the paper. A particular study by Chen et al. (2019) showed the connection between increasing AgNP content and the color of the paper samples. The pure paper was white and the increasing AgNP content resulted in the darkening of the brown shade in the paper. Hence, in the synthesis process, a darker shade of yellow-brown is preferred which is indicative of higher AgNP content.

There were nine (9) treatments in the experimental design. To quantitatively compare shades of yellow-brown color produced by each treatment, the photos were analyzed using ImageJ. The photos were first converted to 32-bit grayscale images so that all colors in the images are uniformly converted to shades of gray with varying intensities depending on the original image. Then, the intensities of the gray color in the image were quantified and reflected as a gray value. The mean gray value or MGV refers to the average gray value within a particular selection and is reflective of the brightness or darkness of the selection. For this study, a uniform region of interest was applied to all images.

Shown in Figure 4 is a sample color guide scale that shows the conversion of sample shades of yellow-brown color to grayscale and their equivalent MGV in ImageJ. In the MGV scale used in this study, a plain white color resulted in an MGV of 255 while a plain black color resulted in an MGV of 0. All other resultant images registered MGV between 0 and 255.

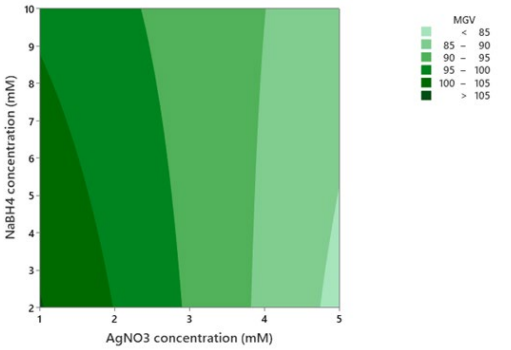


Figure 5. Contour plot visualizing the effect of the concentrations of $AgNO_3$ and $NaBH_4$ on the mean gray value of the paper sensor.

With this, the MGVs of the resulting paper for each treatment were determined and were used as the basis for selecting the best treatment. The treatment that resulted in the paper sensor having the lowest MGV was selected and used for succeeding experiments as this corresponded to the paper having the highest AgNP content. Table 2 shows the experimental design and the measured response of the design.

Using two-way ANOVA, results indicate that the means of observations grouped by $AgNO_3$ concentration are not the same and it is a statistically significant factor with a p-value of 2.21×10^{-6} which is less than alpha of 0.05. The means of observations grouped by $NaBH_4$ concentration are the same and it is not a statistically significant factor with a p-value of 0.61 which is greater than the alpha of 0.05. The interaction of the two factors is statistically significant with a p-value of 7.72×10^{-4}

Table 2. Experimental design with corresponding MGV per treatment. The standard deviation per treatment was measured from three trials with three replicates each.

Treatment	Coded matrix		Experimental values		C	Std. dev.
	A	B	A	B		
1	-1	-1	1	2	108.72	5.20
2	-1	0	1	6	97.93	3.61
3	-1	+1	1	10	95.98	2.30
4	0	-1	3	2	86.89	6.72
5	0	0	3	6	103.95	5.46
6	0	+1	3	10	98.43	5.87
7	+1	-1	5	2	86.22	1.85
8	+1	0	5	6	82.63	3.70
9	+1	+1	5	10	83.19	6.27

Table 3. Comparison of absorbance peaks of materials with AgNP obtained through DRS.

Material	Absorbance peak	Reference
AgNP colloid	417.4 nm	An et al., 2015
poly(methyl methacrylate/styrene)/Ag	423..8 nm	An et al., 2015
polysulfone membrane with 2.0 wt% AgNP	418 nm	Andrade et al., 2015
polysterene/Ag nanocomposite	411 nm	Wang et al., 2008
Whatman 41 filter paper with AgNP	417 nm	This study

which is less than the alpha of 0.05. A visual representation of the relationship between the independent variables (concentration of $AgNO_3$ and $NaBH_4$) and the dependent variable (MGV) is shown through the contour map in Figure 5. In agreement with the previous statements, Figure 5 shows that as the concentration of $AgNO_3$ increases, a significant effect in the MGV is observed as the color lightens. Moreover, the concentration of the $NaBH_4$ in the y-axis does not greatly affect the dependent variable.

In terms of selecting the best treatment, the paper having the lowest MGV was chosen as this correlates to having the highest AgNP content. As observed in Table 2, treatments 8 and 9 have the lowest average MGV. However, additional statistical tests must be performed because of the proximity of their values. Upon conducting a t-test, the results show that the means of the observations between the two treatments are not statistically different from each other with a p-value of 0.90 which is greater than the alpha of 0.05. With this, treatment 8 (5 mM $AgNO_3$ and 6 mM $NaBH_4$) was chosen because it still registered the lowest MGV and it used less amount of $NaBH_4$ reagent. This is also consistent with the earlier result that $NaBH_4$ is not a statistically significant factor, hence choosing a higher 10 mM $NaBH_4$ solution would only consume more reagent but will not significantly affect the MGV.

Characterization of the Bare AgNP Paper Sensor

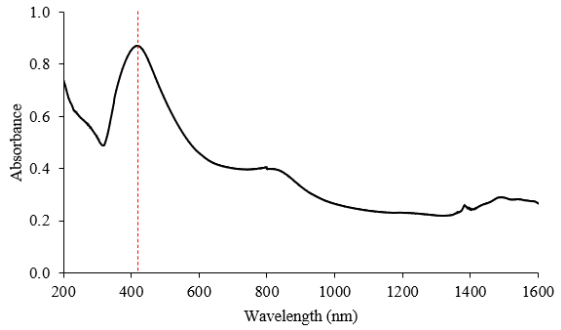


Figure 6. DRS analysis of the bare AgNP paper sensor showing absorbance peak at 417 nm.

Diffuse Reflectance Spectroscopy Analysis

The spectral properties of AgNP can be investigated using DRS. The absorbance spectrum of the bare AgNP paper sensor is presented in Figure 6. A scan from 200 to 1600 nm shows a sharp and prominent peak at 417 nm with an absorbance value of 0.87.

The DRS result confirms the presence of bare AgNPs on the paper as the wavelength of the peak position corresponds to AgNPs which is due to their SPR property. Additionally, the sharp and symmetrical peak suggests that the bare AgNP's size distribution is narrow (An et al., 2015). The absorbance peak at 417 nm obtained in this study is very close to the DRS peaks of AgNPs in the literature as presented in Table 3.

Scanning Electron Microscopy-Energy Dispersive X-ray Spectroscopy analysis

Presented in Figure 7 is the SEM image of the filter paper (A) and the paper sensor (B). The successful incorporation of the AgNPs on the paper visually turned its color from white to yellow-brown. This is supported by the attachment of the bare AgNP in the cellulosic fibers of the paper (B) after the synthesis process. The well-distributed AgNPs prove that the fibers of the paper provide a good binding site for metallic nanoparticles. Notably, Figure 8 shows a magnified image of the paper sensor with AgNP particles with an approximate particle size range of 96 nm to 127 nm.

Furthermore, the EDS spectrum also confirms the presence of AgNP in the paper sensor. Figure 9 reports a strong signal of the silver peak at 3 keV, which is typically detected for metallic silver nanoparticles (Liang et al., 2017), and it accounts for 2.05 wt%. The elemental mapping in Figure 10 shows that the relative distribution of the silver, represented as green dots, are spread evenly within the paper. This further suggests that the chosen paper platform, Whatman no. 41, is able to keep the nanoparticles within its cellulose fibers. The presence of AgNP affirms the result of the DRS analysis shown in Figure 6.

Romblon State University Research Journal
ISSN: 2619-7529 (Online) | ISSN: 2350-8183 (Print)
Volume 5 (2): 1-11, 2023

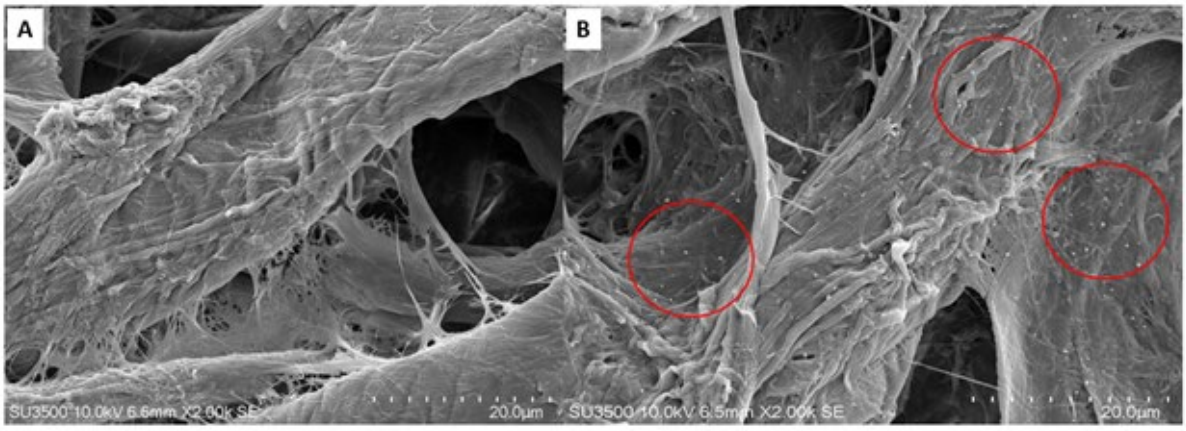


Figure 7. SEM images of (A) the plain filter paper showing its porous structure and clean fibers and (B) the paper sensor showing the synthesized AgNP deposited on the fibers appearing as white spots.

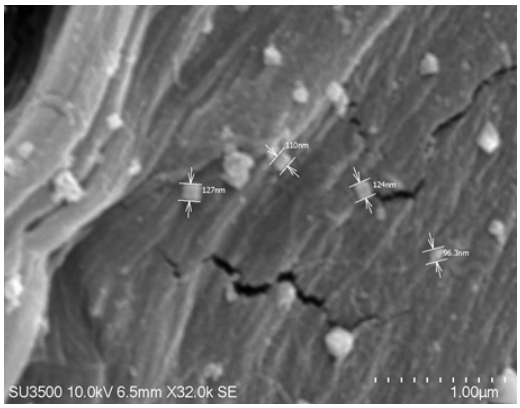


Figure 8. A magnified SEM image of the paper sensor showing an approximate AgNP particle size range of 96 nm to 127 nm.

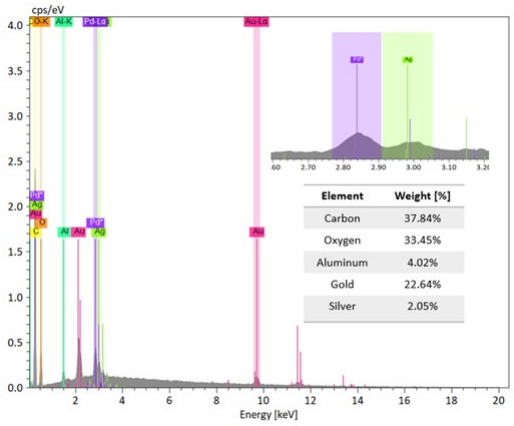


Figure 9. EDS spectrum and weight percentage distribution of the elements in the bare AgNP paper sensor.

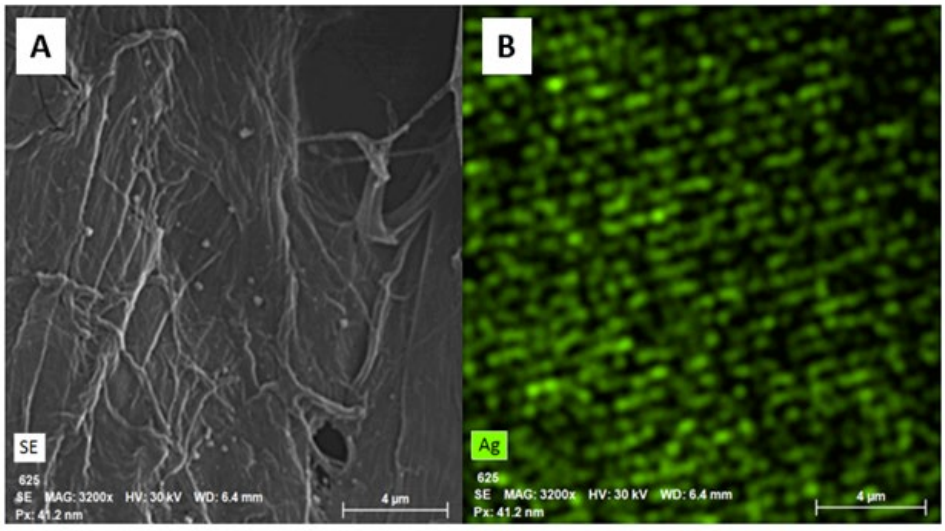


Figure 10. EDS elemental mapping of the (A) area of interest of the sensor, showing the (B) distribution of Ag.

Response to Cu(II) Ions

Change in Mean Gray Value. To test the potential of the platform for Cu(II) sensing application, the papers were exposed to varying Cu(II) concentrations. Figure 11 shows the effect of increasing Cu(II) concentration to the MGV of the paper sensor.

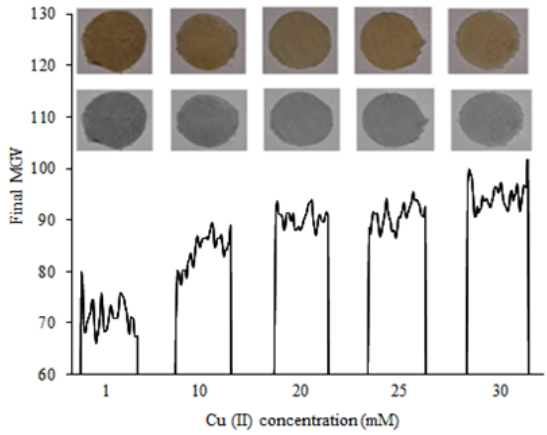


Figure 11. Effect of increasing Cu (II) concentration on the final MGV of the bare AgNP paper-based sensor. Top row photos are the actual images taken inside the monitoring box while bottom row photos are the corresponding grayscale images. Bar graph represents the MGV profile within each paper sample.

To generate Figure 11, photos of the actual paper sensors were converted to grayscale images. Then in ImageJ analysis, the grayscale images were set against a black background to remove gray values that do not belong to the region of the paper sensor. Then, a linear region of interest was drawn to obtain a plot profile of the MGV across the papers. In the figure, as the concentration of Cu(II) ions is increased from 1 to 30 mM, the final MGV of the bare AgNP paper appears to be increasing as well. The increase in MGV indicates the lightening of the brown color of the papers within the range specified.

In terms of visual monitoring, comparing the paper exposed to 1 mM and the paper exposed to 30 mM Cu(II), one can observe that the brown shade of the 30 mM Cu-exposed paper is lighter compared to that of the 1 mM Cu-exposed paper. However, the color changes are difficult to detect by the naked eye for other tested concentrations between 1 and 30 mM. Hence, the assistance of software for image analysis is very important. Using ImageJ, the MGV of the paper exposed to 30 mM Cu(II) registered a higher MGV compared to paper exposed to 1 mM Cu(II). This increase in MGV is consistent with the observed lightening of the brown shade of the paper. The relationship between MGV and the shades of color was presented earlier in Figure 4.

Relationship of Cu(II) Concentration and Mean Gray Value (MGV)

A plot of the ratio of the mean gray values ($MGV_{final}/MGV_{initial}$) and Cu(II) concentration was generated and is presented in Figure 12. Each point in the graph represents the average of three trials with each trial having three replicates. The error bars represent the standard deviation.

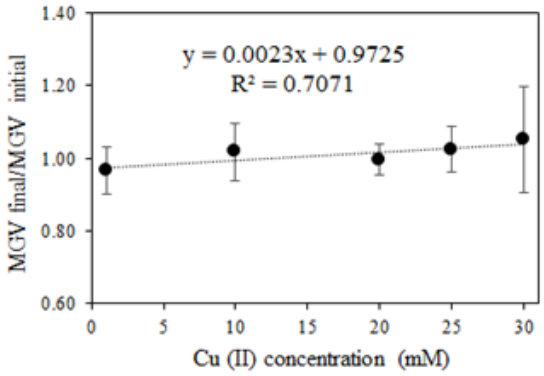


Figure 12. Relationship of $MGV_{final}/MGV_{initial}$ and Cu (II) concentration up to 30 mM. Generating a linear profile results to a coefficient of determination value of 0.7071 and a positive slope of 0.0023.

The plot in Figure 12 shows that as the Cu(II) concentration is increased, the ratio $MGV_{final}/ MGV_{initial}$ appears to be increasing as well. If a linear profile is generated for the two parameters, the coefficient of determination is 0.7071 with a positive slope of 0.0023. The positive slope affirms that as the Cu(II) concentration is increased, the MGV ratios of the paper increase as well. This translates to the papers generally lightening in color when exposed to Cu(II) within the tested range. However, the value of the coefficient of determination implies that the increase in the MGV ratios is not strongly linear to Cu(II) concentration of the tested range.

Elemental Composition Changes

The response of the bare AgNP paper-based sensor after its exposure to Cu(II) solution was evaluated using SEM-EDS analysis. SEM analysis shows that the filter paper retains its porous structure after addition of 100 mM Cu(II) solution. On the other hand, EDS analysis shows that unlike the EDS spectrum of the paper sensor seen in the previous section, Figure 13 presents the detection of the Cu in its EDS spectrum as expected due to its exposure. The elemental mapping of the copper-exposed paper sensor presented in Figure 14 shows the

Romblon State University Research Journal
ISSN: 2619-7529 (Online) | ISSN: 2350-8183 (Print)
Volume 5 (2): 1-11, 2023

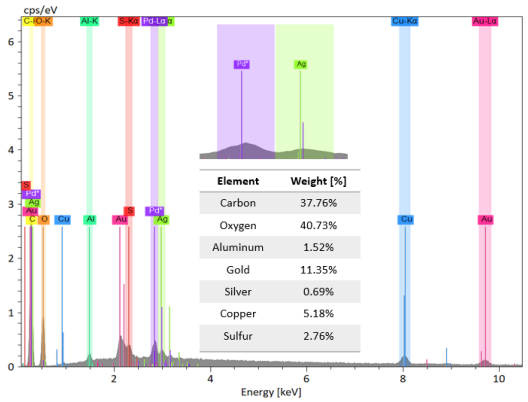


Figure 13. EDS spectrum of the paper sensor after exposure to 100 mM Cu (II) solution

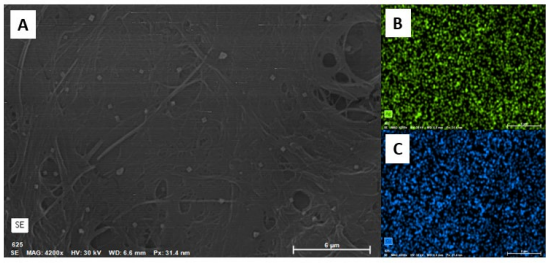


Figure 14. EDS elemental mapping of the (A) area of interest of the sensor exposed to 100 mM Cu(II) solution showing the presence of (B) silver in green dots and (C) copper in blue dots.

distribution of the elements of the area of interest - green dots for silver and blue dots for copper. The weight percentage distribution reported a 5.18 wt% for copper. Moreover, the introduction of Cu(II) caused a decrease in the percent distribution of the silver. Compared to the previous 2.05 wt % reported, only 0.69 wt% silver was detected after its addition. The decrease in silver percentages could explain why the papers were slightly lighter in color after Cu(II) exposure. Potentially, complexes were formed between the silver and copper ions that caused the alteration of the morphologies and characteristics of the nanoparticles, thus, resulting in the decrease of its wt % distribution in the sensor.

Response Comparison with Other Common Ions

The response of the bare AgNP paper to other common ions was investigated and plotted in comparison to Cu (II) ions. The plot comparison is shown in Figure 15. The bars represent the average of three trials while the error bar represents the standard deviation.

Based on Figure 15, only Cu(II) showed a positive change in MGV among the tested ions. This indicates that exposure to Cu(II) generally lightens the yellow-brown color of the paper while the effect of the other ions is the reverse. This implies that the bare AgNP paper-based sensor behaves differently when exposed to a low concentration of Cu(II) ions than the rest of the tested ions.

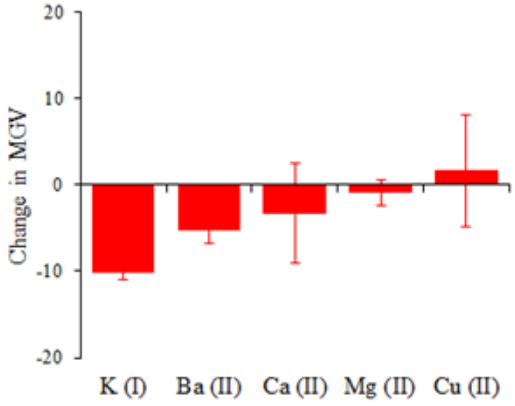


Figure 15. Comparison of responses among different common ions show only Cu (II) registered a positive increase in MGV.

CONCLUSION

Bare AgNP paper sensor was successfully fabricated and characterized in terms of its spectral and morphological properties, as well as its elemental properties. Silver nanoparticles were synthesized in situ the paper using the best concentrations of the precursor and reducing agent as identified through a full factorial design. Different techniques such as DRS, SEM, and EDS were utilized that confirm the presence of AgNP on the fibers of the filter paper. SEM-EDS analysis also shows that the filter paper retains its porous structure before and after exposure to copper ions. In addition, MGV analysis using ImageJ processing software, and SEM-EDS analysis were performed to test the response of the filter paper to the copper ions. Lightening of the paper sensor was observed after exposure to copper ions compared with other tested ions, however, as a recommendation, testing and incorporating functionalizing agents could improve the overall response of the sensor.

ACKNOWLEDGMENT

The researchers wish to thank the financial support of the University of the Philippines Visayas through the Small Budget In-House Research Grant (SBIRG), the School of Technology, UPV, the DOST RA 7687

Scholarship for the thesis allowance, the AVAMOS Research Group for their support during the conduct of the additional experiments, and the Material Science and Nanotechnology Laboratory of the UPV Regional Research Center for their assistance during the SEM-EDS analysis.

AUTHORS' CONTRIBUTIONS

FEA conceptualized and secured funding for the study through the Small Budget In-house Research Grant. All authors contributed to the data gathering, manuscript writing, and analysis. Also, all authors checked and approved the final manuscript.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

REFERENCES

Almaquer, F.E., & Perez, J.V. (2019). Evaluation of the colorimetric performance of unmodified citrate-stabilized silver nanoparticles for copper (II) sensing in water. *Key Engineering Materials, 821*,372-378. https://doi.org/10.4028/www.scientific.net/kem.821.372

AL-Thabaiti, S. A., Al-Nowaiser, F. M., Obaid, A. Y., Al-Youbi, A. O., & Khan, Z. (2008). Formation and characterization of surfactant stabilized silver nanoparticles: A kinetic study. *Colloids and Surfaces B: Biointerfaces, 67*(2), 230–237. https://doi.org/10.1016/j.colsurfb.2008.08.022

An. J., Luo, Q., Li, M., Wang, D., Li, X., & Yin, R. (2015). A facile synthesis of high antibacterial polymer nanocomposite containing uniformly disperse silver nanoparticles. *Colloid and Polymer Science, 293*(7), 1997-2008. https://doi.org/10.1007/s00396-015-3589-5

Andrade, P. F., de Faria, A. F., Oliveira, S. R., Arruda, M. A., & Goncalves, M. D. (2015). Improved antibacterial activity of nanofiltration polysulfone membranes modified with silver nanoparticles. *Water Research*, *81*, 333-342. https://doi.org/10.1016/j.watres.2015.05.006

Bost, M., Houdart, S., Oberli, M., Kalonji, E., Huneau, J., & Margaritis, I. (2016). Dietary copper and human health: Current evidence and unresolved issues. *Journal of Trace Elements in Medicine and Biology*, 35, 107-115 https://doi.org/10.1016/j.jtemb.2016.02.006

Budlayan, M. L., Patricio, J. N., Lagare, J. P., de la Rosa, L. B., Arco, S. D., Alguno, A. C., Austria, E. S., Manigo, J. P., & Capangpangan, R. Y. (2021). Functionalized silver nanoparticle-decorated paper sensor for rapid colorimetric detection of copper ions in water. *Functional Composites and Structures, 3*(3), 035007. https://doi.org/10.1088/2631-6331/ac25e9

Chaiyo, S., Siangproh, W., Apilux, A., & Chailapakul, O. (2015). Highly selective and sensitive paper-based colorimetric sensor using thiosulfate catalytic etching of silver nanoplates for trace determination of copper ions. *Analytica Chimica Acta, 866*, 75-83. https://doi.org/10.1016/j.aca.2015.01.042

Chen, G., Yan, L., Wan, X., Zhang, Q., & Wang, Q. (2019). In situ synthesis of silver nanoparticles on cellulose fibers using D-glucuronic acid and its antibacterial application. *Materials, 12*(19), 3101. https://doi.org/10.3390/ma12193101

Dankovich, T. A., & Gray, D. G. (2011). Bactericidal paper impregnated with silver nanoparticles for point-of-use water treatment. *Environmental Science & Technology, 45*(5), 1992-1998. https://doi.org/10.1021/es103302t

Dankovich, T. A. (2014). Microwave-assisted incorporation of silver nanoparticles in paper for point-of-use water purification. *Environmental Science: Nano, 1*(4), 367-378. https://doi.org/10.1039/c4en00067f

Desai, V. & Kaler, S. G. (2008). Role of copper in human neurological disorders. *The American Journal of Clinical Nutrition, 88*(3). https://doi.org/10.1093/ajcn/88.3.855s

He, J., Kunitake, T., & Nakao, A. (2003). Facile in situ synthesis of noble metal nanoparticles in porous cellulose fibers. *Chemistry of Materials, 15*(23), 4401-477 4406. https://doi.org/10.1021/cm034720r

Helaluddin, A. B. M., Khalid, R. S., Alaama, M., & Abbas, S. A. (2016). Main analytical techniques used for elemental analysis in various matrices. *Tropical Journal of Pharmaceutical Research, 15*(2), 427-434. https://doi.org/10.4314/tjpr.v15i2.29

Khodashenas, B., & Ghorbani, H. (2014). Synthesis of silver nanoparticles with different shapes. *Arabian Journal of Chemistry, 12*(8), 1823–1838. https://doi.org/10.1016/j.arabjc.2014.12.014

Kirubaharan, C. J., Kalpana, D., Lee, Y. S., Kim, A. R., Yoo, D. J., Nahm, K. S., & Kumar, G. G. (2012). Biomediated silver nanoparticles for the highly selective copper (II) ion sensor applications. *Industrial & Engineering Chemistry Research, 51*(21), 7441-7446. https://doi.org/10.1021/ie3003232

Liang, M., Zhang, G., Feng, Y., Li, R., Hou, P., Zhang, J., & Wang, J. (2017). Facile synthesis of silver nanoparticles on amino-modified cellulose paper and their catalytic properties. *Journal of Materials Science, 53*, 1568–1579. https://doi.org/10.1007/s10853-017-1610-8

Li, Z., Wang, Y., & Yu, Q. (2009). Significant parameters in the optimization of synthesis of silver nanoparticles by Chemical Reduction Method. *Journal of Materials Engineering and Performance, 19*, 252–256. https://doi.org/10.1007/s11665-009-9486-7

Ma, Y.-rong., Niu, H.-yun., Zhang, X.-le., & Cai, Y.-qi. (2011). Colorimetric detection of copper ions in tap water during the synthesis of silver/dopamine nanoparticles. *Chemical Communication, 47*(47), 12643. https://doi.org/10.1039/c1cc15048k

Mulfinger, L., Solomon, S. D., Bahadory, M., Jeyarajasingam, A. V., Rutkowsky, S. A., & Bortiz, C. (2007). Synthesis and study of silver nanoparticles. *Journal of Chemical Education, 84*(2), 322. https://doi.org/10.1021/ed084p322

Nery, E. W., & Kubota, L. T. (2013). Sensing approaches on paper-based devices: A Review. *Analytical and Bioanalytical Chemistry, 405*, 7573-7595. https://doi.org/10.1007/s00216-013-6911-4

Pourreza, N., & Golmohammadi, H. (2014). Colorimetric sensing of copper based on its suppressive effect on Cloud Point extraction of label Free Silver Nanoparticles. *Analytical Methods, 6*(7), 2150-2156. https://doi.org/10.1039/c3ay42149j

Ratnarathorn, N., Chailapakul, O., Henry, C. S., & Dungchai, W. (2012). Simple silver nanoparticle colorimetric sensing for copper by paper-based devices. *Talanta, 99*, 552-557. https://doi.org/10.1016/j.talanta.2012.06.033

Swensson, B., Ek, M., & Gray, D. G. (2018). In situ preparation of silver nanoparticles in paper by reduction with Alkaline Glucose Solutions. *ACS Omega, 3*(8), 9449-9452. https://doi.org/10.1021/acsomega.8b01199

Vilela, D., Gonzalez, M. C., & Escarpa, A. (2012). Sensing colorimetric approaches based on gold and silver nanoparticles aggregation: Chemical creativity behind the assay. A review. *Analytica Chimica Acta, 751*, 24-43. https://doi.org/10.1016/j.aca.2012.08.043

Wang, D., An, J., Luo, Q., Li, X., & Li, M. (2008). A convenient approach to synthesize stable silver nanoparticles and silver/polysterene nanocomposite particles. *Journal of Applied Polymer Science, 110*(5), 3038-3046. https://doi.org/10.1002/app.28442

Romblon State University Research Journal
ISSN: 2619-7529 (Online) | ISSN: 2350-8183 (Print)
Volume 5 (2): 18-23, 2023

Structural and Functional Analysis of *Bansag* Narratives in Barangay Maslog, Legazpi City, Albay Philippines

Ria Charo R. Morato[1] and Edgardo L. Besmonte[2]

ABSTRACT

This paper collected, transcribed, translated, and analyzed the folk narratives on bansag in Barangay Maslog, Legazpi City. It employed the Labovian method to examine the narratives' structures and Bascom's functionalism approach to determine the functions of the narratives. This paper concludes that the narrator's storytelling technique greatly affects the structural pattern of the folk narratives. The completeness or incompleteness of the structure of the narratives will never diminish the essential nature and functions of folk narratives. Folk narratives through the passing of time will always be an important oral tradition. They still served their purpose in the community. However, folk narratives as a form of oral literature are under threat since many details of the narratives diminished or were lost through oral transmission from generation to generation. Since oral narratives are on the verge of extinction, this paper recommends to incorporate these narratives in the curriculum to safeguard and preserve the oral narratives.

Keywords: *culture, functional analysis, oral narratives, structural analysis*

INTRODUCTION

Culture refers to the values and beliefs shared by a specific group of people. It is a complex whole that includes knowledge, beliefs, arts, laws, morals, customs, and any other capabilities and habits acquired by man as a member of society. Culture influences how people learn and behave in a certain society (Tylor, 1984).

Every society has its belief system, cultural practices, and folklore that reflect people's culture. Folklore is considered as old as history, and it has many things to offer. Folklore had been part of the lives of our ancestors. Our old folks perpetuated their own popular beliefs and practices discernible in the folklore. Folklore is a general term for any culture's verbal, spiritual, and material aspects transmitted orally, by observation, or by imitation. People sharing culture may have commonalities in occupation, language, ethnicity, or geographical location. The said traditional materials are preserved and passed on from generation to generation, with some variations shaped by memory (Eslit, 2017). Folklore ensures the longevity and immortality of cultural heritage (Velez, 2021). There is a need to appreciate and understand people's unique beliefs and practices to accept other people's cultural differences.

Jocano (1969) believed that society produced its literature because it preserves its legacy and gives shape and meaning to its values and aspirations through this medium. Oral and written literature representing people's lifestyles fosters knowledge and understanding among members of any particular culture. It helps civilization to document and save its priceless legacy for consideration, research, and advancement in the future.

Studying the existing oral tradition of *bansag* in Barangay Maslog, Legazpi City, was a worthy undertaking for people to appreciate the oral traditions that existed up to this time. The advent of modernization made people less interested in beliefs and traditions but the culture and indigenous practice of giving *bansag* continued to thrive despite the passing of time. Through this study, the education curriculum committee may be guided in updating the instructional materials being used by harnessing the local literature. They may include stories that adhere to localization and indigenization so that the students of today will value the literary pieces in the locality and not just those written by other Filipinos and foreign writers. This is also a way of developing a sense of nationalism among the younger generation.

Meanwhile, in Philippine society, certain beliefs and oral traditions exist. One of the many Filipino oral

✉ elbesmonte@bicol-u.edu.ph
[1]Orosite High School, Legazpi City; [2]Bicol University, Legazpi City
Received 20 June 2023; Revised 7 December 2023; Accepted 14 December 2023

traditions includes giving *bansag* or moniker to a person. It is from this context that Philippine literature has produced fictional characters such as "Juan Tamad", "Juan Osong", and "Pedro Penduko" among others. These names were coined because of these characters' characteristics and traits which became their *bansag* or moniker.

In the Bicol region, an oral tradition existed locally known as *bansag* which was given to a specific person or clan. The said tradition was a common practice in one of the barangays in Legazpi City which is Barangay Maslog. These traditions had become helpful when looking for a specific person by just mentioning the *bansag*. Barangay Maslog is located at the western rim of the Albay Gulf, a few kilometers south of Legazpi Port. It was said to be triangular. This community could be reached by land and by sea.

Barangay Maslog as a community had a population of 4,350 and a land area of approximately 667 hectares. It is composed of 10 *puroks* or *sitios* namely; Centro, Pangulo, Polique, Gumihan, East San Jose, West San Jose, West Pigbidayan, East Pigbidayan, Oraroy, and Macaradat. The people of Barangay Maslog, Legazpi City believed that there were significant meanings attached to their moniker and each *bansag* had an interesting origin that had been passed on to the next generation.

A culture's folklore plays a significant role in defining its values, attitudes, and beliefs. It is often shared between a group of people who have things in common, such as language, ethnicity, geography, age, or occupation. Folklore is a collaborative process that combines creation, communication, and performance. It is a significant means through which people can connect with and impart their cultural legacy to others. It is from this context that this research was conducted to collect and translate the narratives on *bansag* in Barangay Maslog, Legazpi City, and analyze their narratives' structures in terms of abstract, orientation, complicating action, evaluation, and resolution and determine the function of the said narratives in the community.

METHODOLOGY

This study employed a qualitative design of research. It is a type of social science research that collects and works with non-numerical data that seeks to interpret meaning from the available data to help understand social life through the study of targeted populations or places (Crossman, 2020).

The collection of the narratives on *bansag* from Barangay Maslog, Legazpi City employed community immersion through *Sikolohiyang Pilipino* of Enriquez (Marcelino & Pua, 2000). During the mapping or collection of the folk narratives, the *bansag* narratives were subjected to horizontal and vertical tests developed by Arsenio Manuel, (1967) to validate their folkloricity and authenticity. The vertical test required three generations of narrators or storytellers who could narrate the narratives while the horizontal test required at least five adaptations of the narratives within the locale of the study.

Further, the narratives that passed either the vertical or horizontal test of Manuel (1967) were subjected to triangulation. This was the process of presenting the recorded data to the informants of the community for validation and further checking and reviewing. Focus-group discussion was also implemented during the validation. The narratives underwent structural analysis employing the methods of William Labov to examine the narratives' structures in terms of abstract, orientation, complicating action, evaluation, and resolution and for the content analysis. Also, the study employed William Bascom's (1965) functional analysis to determine the function of the said narratives in the community.

Treatment of data

The collected narratives on *bansag* should have passed either or both of Manuel's vertical and horizontal tests and community validation to ensure their authenticity. Only those authentic folkloric materials underwent translation and analysis. The narratives collected from the vernacular were transcribed and translated into the English language as faithfully as possible to the text and content. A set of jurors who are native speakers of the Bicol dialect and proficient in the English language reviewed and ensured that the English translation was acceptable.

Moreover, it employed edited transcription as a method in narrative transcription in which the narratives were edited to increase readability. Likewise, grammar editing such as removing run-on sentences and summarizing some parts of the narratives was done to achieve clarity of the narratives (Baum,1977). During transcription, titles were also assigned for easy identification. After the translation, the collected narratives were subjected to Labovian structural analysis and Bascom's functional analysis.

Data Gathering Procedure

The researcher purposely looked for residents of Barangay Maslog, Legazpi City who are 50 years old and above and have resided in the community for a minimum of 15 years regardless of their sex, gender orientation, civil status, and position in the community (Imran, 2017). Thirty-three key informants were given the *bansag* or moniker and participated in this research.

Further, ethnography through community immersion employing the *Sikolohiyang Filipino* or Filipino Psychology (Marcelino & Pua, 2000) that includes "*pagtatanong-tanong*" (improvised, informal,

unstructured interview), "*pagdalaw-dalaw*" (visiting), "*pakikisama*" (getting along with), "*pakikiramdam*" (sensitivity) and "*pakikipagkwentuhan*" (informal conversation) was the primary method in data collection. The main source of primary data were 33 narratives on *bansag* obtained from key informants in Barangay Maslog, Legazpi City.

At the onset of data collection, ethical guidelines were observed. First, informed consent was asked from the key informants. The researcher asked permission from the participants to record and take some photos for documentation. Moreover, respect for the participants, local values, and language was also observed. The researcher maintained proper behavior at all times. During the narration, the researcher recorded the narratives through paper and pen and a video recording machine.

RESULTS AND DISCUSSION

Narrative Structure and Functions

After the validation of folkloricity and authenticity of folk narratives through community validation and vertical and horizontal tests of Arsenio Manuel (1976), each narrative was subjected to structural narrative analysis applying the narrative elements proposed by William Labov (1972). These narrative elements included abstract or summary, orientation, complicating action, evaluation, resolution, and coda.

The abstract included a summary of the narrative. The orientation described the setting, time, place, characters, and situations. The complicating action is the section of the narrative informing the audience about what happened. Evaluation was part of the narrative that explained why the narrative was worth telling. The result or resolution contained the section informing the audience about how the action was resolved.

Findings revealed that all 33 collected narratives on "*bansag*" or monikers had the abstract, 27 narratives reflected evaluation, 25 narratives revealed complication and the resolution while 18 narratives described the orientation. These findings suggested the style of the narrator telling the story. The narrator would start the narration of the tales by giving a summary or abstract of the story. The narrator vividly remembered the main events of their experiences which is why all narrators or storytellers would give a summary of their experiences at the onset of the narratives. This idea was supported by Labov (1972) that narrative was recapitulating past experiences that matched the sequence of events that occurred. Table 1 shows the combinations of the structural elements of the narratives.

Further, 27 narratives revealed the evaluation of the narratives. Narrators would expound in this part the significance of their experience. Based on the findings, the narrators would immediately proceed to explain the significance of the experience after giving a summary of their experience.

Table 1. Structural patterns of the *bansag* narratives

Combination of Elements	Total
abstract-orientation-complicating action-evaluation and resolution	7
abstract-complicating action-evaluation and resolution	4
abstract-complicating action-resolution	4
abstract-orientation-complicating action-evaluation	3
abstract- orientation-evaluation and resolution	3
abstract -complicating action-evaluation and resolution	3
abstract-orientation-complicating action-resolution	2
abstract- complicating action-evaluation	2
abstract- orientation- evaluation	2
abstract-orientation- resolution	2
abstract-evaluation-resolution	1

Moreover, 25 narratives explained the complication of their experience and in return, detailed how the narrators were able to solve the complication in the evaluation part of the narrative. This could mean that some narrators would elaborate on their experiences by presenting the conflicts or complications and explaining how they solved the complications.

Lastly, 18 narratives detailed the setting, the time, place characters, and situations. This could mean that there are storytellers who cannot remember the details of the narratives. This was because since folk narratives were transmitted orally, many details in terms of the time, place, and situation diminished through the oral transmission of the narratives.

Findings also revealed that among the 33 narratives collected from Barangay Maslog, Legazpi City, seven narratives were fully formed narratives that followed the abstract-orientation-complicating action-evaluation and resolution pattern, while four narratives followed the abstract-complicating action-evaluation and resolution pattern. In addition, four narratives followed the abstract-complicating action-resolution pattern, then three narratives followed the abstract-orientation-complicating action-evaluation pattern.

On the other hand, three narratives followed the abstract-orientation-evaluation and resolution pattern, while three narratives followed the abstract-complicating action-evaluation and resolution pattern, also two narratives followed the abstract-orientation-complicating action and resolution pattern. Similarly,

two narratives followed the abstract-orientation-resolution pattern, two narratives followed the abstract-complicating action-evaluation pattern, then two narratives followed the abstract-orientation-evaluation pattern and one narrative followed the abstract-evaluation-resolution pattern.

Based on the structural pattern, it was evident that seven narratives followed the abstract-orientation-complicating action-evaluation and resolution pattern. Four narratives followed the abstract-complicating action-evaluation and resolution pattern. Three narratives followed the abstract-orientation-complicating action-evaluation pattern these were the narratives. Three narratives followed the abstract-orientation-evaluation and resolution pattern.

Additionally, three narratives followed the abstract -complicating action-evaluation and resolution pattern. Two narratives followed the abstract-complicating action-evaluation pattern. Also, two narratives followed the abstract-orientation-evaluation patterns. Two narratives followed the abstract-orientation-resolution pattern Lastly, one narrative followed the narrative abstract-evaluation-resolution pattern. Based on the findings, only seven narratives contained the complete structure and had all the elements. On the other hand, 26 out of 33 narratives were not fully formed narratives which means one or more narrative structures were missing.

The findings implied that the majority of the collected narratives did not possess complete structure. This could be attributed to the narrator's manner of telling the story. Some narrators were careful in narrating all the information in the story while some only highlighted what they remembered. These findings have corroborated the findings of Imran (2017) stating that narrative structure was fully dependent upon the storyteller. The storytellers who were the carriers of the oral tradition were responsible for the transmission of the oral narratives to the next generation. However, this study suggested that the completeness or incompleteness of the structures of the folk narratives will never diminish the essential nature of folk narratives. Folk narratives over time will always be an important component of the oral literature of every community.

However, folk narratives such as the narratives on *bansag* may diminish in due time. Besmonte (2022) noted that the declining number and death of practitioners were seen as threats to preserving intangible heritage such as folk literature. Moreover, Imran (2017) believed that if many storytellers were forgetful, hurried, and careless, large parts of the oral records could be lost in generational transmission.

Functions of the Bansag Narratives

Based on the analysis of the collected data, the following were revealed:

As a Pedagogic Device. In the olden times, folk narratives have been used as pedagogic devices to convey significant lessons that helped people understand their environment. The collected narratives on *bansag* are used to teach children important life lessons, such as the importance of hard work which was evident in the narratives titled "*Kambing"* wherein the main characters were known to be industrious and hardworking as they work untiringly on the farm that they forgot their hygiene.

Similarly, some narratives can be used to reinforce cultural values such as the importance of hospitality which is evident in the narrative titled, "*Pasiguro*" which talks about a man who always wanted to secure food and things because he never wanted to go empty-handed. This narrative taught people to always save and ensure money and things for the future. Moreover, the narrative titled, "*Amatyur*" talks about a man who persevered in joining an amateur singing contest. This narrative taught the value of perseverance and self-confidence. Further, some narratives emphasized the importance of working together and helping one another as a family. This was evident in the narratives titled "*Kambing*" and "*Baranggot*" where the main characters worked together as one.

The findings implied that the collected narratives on *bansag* were used as a tool in conveying important lessons, values, and cultural beliefs since they were an integral part of a community's oral tradition.

Escape from Repression. Folk narratives as a form of oral literature could also serve as an avenue for enjoyment, entertainment, and a means of escape from the routine of everyday life. Many oral narratives featured magical creatures with supernatural powers that can transport readers to a different form of reality. Through these make-believe characters, readers can experience a sense of freedom from the ordinary aspects of their lives. Oral narratives dealt with themes of social inequality. Exploring this issue allowed the readers to become critical thinkers and determine the power struggle that existed in society. This was evident in the narrative titled "*Bulod*" wherein the grandfather loved climbing the hill and often narrated his adventures and experiences on the hill which made the people around him look forward to more of his adventures.

Similarly, oral narratives dealt with themes of social inequality. The narrative titled "*Udo*" revealed the scenario that due to poverty, the main character could not provide himself with a decent toilet so he would just take a bath and defecate in the river. Unfortunately, the feces floated were seen by the people who were near the

river. Though the narrative was quite funny because it could make the readers smile as they read the narrative, it also caused embarrassment on the part of the main character. This illustrates how the main character's social standing played a role in causing this unfortunate incident.

Lastly, the narrative titled "*Uraro*" reflected a reality that people as rational beings were not allowed to have their public display of affection so they would rather look for unfamiliar places to be able to release their suppressed emotions. This narrative provided comic relief to the readers, knowing that the person involved was seen making love in an arrowroot or *uraro* plantation.

Means of Applying Social Pressure. *Bansag* narratives could serve as a means of applying social pressure in several ways. These narratives could create social expectations and norms that individuals were expected to follow. The narrative titled, "*Piskal*" demonstrated how a family's reputation and social status were closely tied to their behavior and actions. With family members who were lawyers and court fiscals, the community had high expectations of them in terms of intelligence and assertiveness. Moreover, the family's affluent lifestyle had been noticed by the people around them. This means that they must be careful about their behavior and maintain a good image to match the level of their financial status. The family members were expected to live up to the standards set by society since the community expects them to be well-educated and well-mannered. Thus, the family members had to be careful about their actions and behavior to maintain their social status and reputation in the community.

Meanwhile, the narratives titled, "*Ambog*" and "*Dubla*" showed how negative reputations could lead to alienation and shame, putting pressure on the family members to exhibit appropriate behavior to refute the negative reputation. Further, the *bansag* narratives could also create a sense of shame or pride in individuals based on their family's reputation. For example, in the narrative titled, "*Ambog*" the family members were ashamed of their reputation for being boastful and narrating stories that were full of lies. Because of this, they would rather stay at home. This created pressure on them to prove that their reputation was not justified by exhibiting appropriate behavior, such as controlling their temper and avoiding arguments. Similarly, in the narrative "*Piskal*," the family members felt proud of their affluent lifestyle and high social status, creating pressure on them and trying to maintain their image in the community.

Based on the analysis, it could be inferred that the narratives could create social expectations and norms that individuals were expected to follow. In general, *bansag* narratives were used to socialize individuals into a particular cultural group by promoting shared values, norms, and beliefs. Through these narratives, individuals learned how to behave in various social situations and how to interact with others in the community.

Validating Culture

Culture pertains to the customs, traditions, and practices that are observed by the people in the community. The practice of *baransagan* or *bansag* (moniker) was reflected in all the collected narratives. The practice of *baransagan,* wherein a person, family, or clan was given monikers based on appearance and behavior, existed several years ago but still, it was being observed by the Albayanos, especially in Barangay Maslog, Legazpi City. All of the gathered narratives clearly showed how a person or clan earned the moniker. Monikers were formed based on the physical appearance or special skills, abilities, or peculiarities of people.

Culturally speaking, the use of monikers had both positive and negative connotations. These monikers could either be complimentary or derogatory, depending on the context and the person's perception of them. On the positive side, these monikers could be used as a form of identity or easy recognition within the community. They could also serve as a source of pride for individuals who had unique physical traits or special skills. In some cases, these monikers could even become a source of respect for the families they represent. On the negative side, these monikers could also be a form of discrimination especially if they were based on physical appearance. They could reinforce biases towards certain groups of people, leading to social exclusion. In addition, these monikers could be hurtful or offensive to the individual or clan who had the moniker, so the people in the community should be sensitive enough to call the person with the moniker.

Additionally, the practice of using *bansag* served as a guide for the members of a community on how to interact with individuals from different clans. This moniker anticipated a person's behavior towards others (Balin, 2017). In other words, it sets a precedent for how they should interact with people from different backgrounds.

Lastly, folk narratives provided an avenue for the transmission of values and validation of culture. They served as a tool for teaching children and young people about societal norms, expectations, and values. These narratives could help ensure that the younger generation will be raised with a strong sense of cultural identity and values, which they could adapt as they grow older. Furthermore, folklore served as a vessel for carrying the values, practices, beliefs, morals, behavioral codes, and other unique aspects of society across countless generations (Paderan, 2017).

CONCLUSION

This study concludes that the narrator's storytelling technique greatly affects the structural pattern of the folk narratives. The completeness or incompleteness of the structure of the narratives will never diminish the essential nature and functions of folk narratives. Folk narratives, over time, will always be an important oral tradition. They still served their purpose in the community. However, folk narratives as a form of oral literature are under threat since many details of the narratives diminished or were lost through oral transmission from generation to generation. Since oral narratives are on the verge of extinction, this paper recommends incorporating these narratives into the curriculum to safeguard and preserve oral narratives.

AUTHORS' CONTRIBUTIONS

All authors contributed to the data gathering, manuscript writing, and analysis. Also, all authors checked and approved the final manuscript.

CONFLICT OF INTEREST

The author declares no conflict of interest.

REFERENCES

Balin, A. (2017). Folk Narratives on Bansag in Lidong, Sto. Domingo, Albay [Powerpoint slides]. SlideShare. https://www.slideshare.net/seapheus/folk-narratives-on-bansag-or-namecallings

Bascom, W. (1965). The forms of folklore: Prose narratives. *The Journal of American Folklore, 78*(307), 3-20. https://doi.org/10.2307/538099

Besmonte, E. (2022). Identification and safeguarding of Intangible Cultural Heritage (ICH) of Tabaco City, Philippines, through cultural mapping. *Journal of Education, Management and Development Studies, 2*(2), 1–10. https://doi.org/10.52631/jemds.v2i2.106

Baum, W. (1977). *Transcribing and editing oral history*. Rowman & Littlefield Publishers.

Crossman, A. (2020) An Overview of Qualitative Research Methods. Direct Observation, Interviews, Participation, Immersion, Focus Groups. Thought Co. Retrieved from https://www.thoughtco.com/qualitative-research-methods-3026555

Eslit, E. (2017). Folk Literature. https://doi.org/10.13140/RG.2.2.19295.15527

Imran, M. A. (2017). Arimbay's verbal lore: An anthology of folktales. *Bicol University Research and Development Journal, 20*(1).

Jocano, L. (1969). *Outline of Philippine mythology*. Centro Escolar University Research and Development Center.

Labov, W. (1972). Some further steps in narrative analysis. *Journal of Narrative & Life History, 7*(1-4), 395–415. https://doi.org/10.1075/jnlh.7.49som

Manuel, A. (1967). On the study of Philippine folklore. In A. G. Manuud (Ed.), *Brown heritage: Essays on Philippine cultural tradition and literature* (pp. 262–263). Quezon City: Ateneo de Manila University Press.

Paderan, M. P. C. (2016). Narratives On Folk Healing In Bato, Camarines Sur. *ADJES (Ahmad Dahlan Journal of English Studies), 3*(1), 63-69.

Marcelino, E. and Pua, R. (2000). Sikolohiyang Pilipino (Filipino psychology): A legacy of Virgilio G. Enriquez. *Asian Journal of Social Psychology, 3*(1), 49–71. https://doi.org/10.1111/1467-839x.00054

Tylor, E. (1984). Definition of Culture. *Wikipedia Commons, Popular Science Monthly 26*. https://en.wikisource.org/wiki/Popular_Science_Monthly/Volume_26/December_1884/Biographical_Sketch_of_E._B._Tylor

Velez, M.C.N. (2021). Folk healing: A Grounded Theory. Journal of English Education and Linguistics, 2(1). https://doi.org/10.56874/jeel.v2i1.407

Romblon State University Research Journal
ISSN: 2619-7529 (Online) | ISSN: 2350-8183 (Print)
Volume 5 (2): 24-32, 2023

RSUSafe: Student Daily Health Record Tracking System for RSU Romblon Campus

Joy Mariz M. Mindoro-Mesana, Lendy Antoinette M. Guro, Kevin Karl B. Rosaroso, Jan Christian B. Mateo, Vanessa V. Mabunga, Nino Rey P. Bautista, and Juliana R. Maligang

ABSTRACT

This study developed RSUSafe, a COVID-19 website dedicated to tracking the daily health records of students at Romblon State University - Romblon Campus. The specific objectives include the creation of an easy-to-use mobile responsive website that can track daily health data for students participating in flexible face-to-face courses. Additionally, the system incorporates a notification mechanism for both the school nurse and symptomatic students, accessible through the school nurse's web portal. This study was conducted in the first semester of academic year 2022-2023. Considering time constraints and student availability, a sample of 100 responses was collected using the convenience sampling method. To ensure the effectiveness of RSUSAFE, proper reporting and evaluation of the acceptance of the system using the ISO/IEC 25010: 2011 standard was also conducted. Results showed that the RSUSafe system is evaluated as highly suitable, highly efficient, highly reliable and highly secured. The results of this study are expected to significantly contribute to improving health surveillance practices in academic institutions.

Keywords: *health tracking website, RSU safe, health report, daily health records*

INTRODUCTION

One of the most recent global public health emergencies is the COVID-19 pandemic, which began in China and has spread to practically every country in the world (Tria, 2020). This disease is caused by a novel coronavirus: SARS-CoV-2, previously known as 2019-nCoV (Guo et al., 2020). Its symptoms include cough, fever and shortness of breath which can be transferred through close contact with an infected person by coughing, sneezing, respiratory droplets or aerosols (Adnan Shereen et al., 2020).

Consequently, schools and universities conducting in-face classes have been temporarily closed due to the risk of faster transmission of the said virus inside the four corners of the learning institution (UNESCO, 2020). This closure has affected more than 1.2 billion learners worldwide with more than 28 million learners in the Philippines (UNESCO, 2020). As a result, the Department of Education came up with guidelines regarding the implementation of online and modular distance learning (Department of Education, 2020). Plans to conduct the pilot implementation of limited face-to-face delivery in low-risk areas of COVID-19 transmission for January 2021 have been approved by the President (Department of Education, 2020b) but were eventually recalled due to the emergence of a new strain of the virus (Department of Education, 2020c).

The reopening of schools must be carefully planned to ensure the safety and well-being of students, teachers, as well as non-teaching staff (Sarmiento et al., 2021). Indeed, even presently, instruction pioneers should connive with apparently incomprehensible decisions that balance health risks associated with face-to-face learning against the instructive requirements and educational needs of students which may be better served when they are attending their physical schools.

Given the abovementioned information, one of the foreseeable conflicts when face-to-face classes resumes is the rampant upsurge of COVID-19 cases in school if minimum health and safety procedures will not be strictly implemented in different areas of learning. Moreover, the rapid spread of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) has exceeded the capacity of many public health agencies to undertake traditional contact tracing (Kleinman & Merkel, 2020). The European Union recommends that relaxing social distancing measures in education such as reopening schools should only occur after there is clear evidence

✉ joymarizmesana@rsu.edu.ph
Romblon State University – Romblon Campus
Received 20 June 2023; Revised 7 December 2023; Accepted 14 December 2023

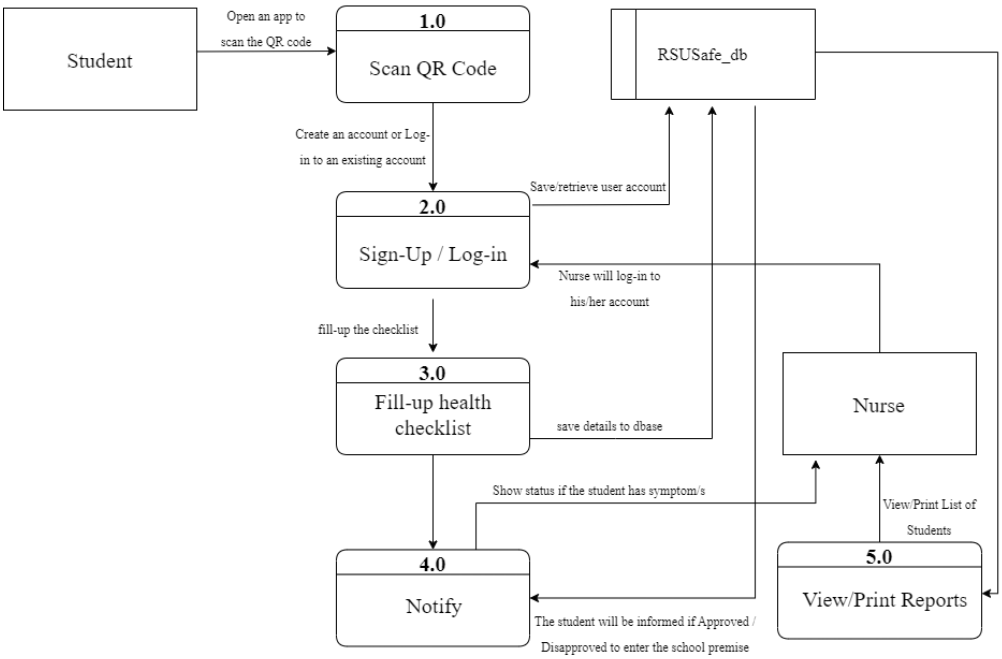


Figure 1. Data Flow Diagram of the System

that the spread has decreased for a significant period, there is sufficient health system capacity to cope with future peaks, and countries have sufficient monitoring and testing capacity to quickly detect and isolate infected people (Day, 2020). Durrheim et al. (2021) affirm that digital contact tracing via a smartphone can be considered as a form of public health intervention against COVID-19. Kleinman and Merkel (2020) asserted that digital contact tracing utilizes electronic information to identify infection exposure; therefore "it has the potential to address limitations of traditional contact tracing, such as scalability, notification delays, recall errors and contact identification in public space."

This study aimed to address the issues mentioned by providing a way to help maintain the health and safety of students who will participate in the said limited face-to-face classes by developing a mobile website that will monitor the daily health record of students from the moment they arrive inside the school premises up to the time they will be returning to their respective homes.

Consequently, contact tracing remains one of the essential and crucial needs in dealing with a pandemic because it allows rapid detection of cases based on information gathered from affected individuals about other people, whom they may have had recent contact with. Advances in digital technologies have made it possible to use cellular phones in the contact tracing process. The mobile website was developed and made possible through the use of Visual Studio Code by Microsoft Corporation. The website provided four main features which will be discussed further in the latter parts of this study. The system employed the student's information, assistance of teaching and non-teaching staff, and the school nurse to determine the health status of those entering the university. This way, contact tracing and exposure mitigation will be manageable inside the campus.

Objectives

This study aimed to develop a COVID-19 website used for tracking student's daily health records in Romblon State University – Romblon Campus which has the following features: user-friendly graphical user interface for students; track the daily health record of students who will participate in the flexible in-face classes; generate a personal Quick Response "QR" Code specific for RSU- Romblon Campus only; notification status for the school nurse and symptomatic student that is posted on the web portal of the school nurse; and produce reports. Moreover, the system was tested for acceptability using the ISO/IEC 25010:2011 standard across functional stability, performance efficiency, reliability, and security.

METHODOLOGY

Data Flow Diagram

A data flow diagram depicts the flow of information through a process or system. It contains information on the procedure, as well as the output and entity (Fig. 1).

Romblon State University Research Journal
ISSN: 2619-7529 (Online) | ISSN: 2350-8183 (Print)
Volume 5 (2): 24-32, 2023

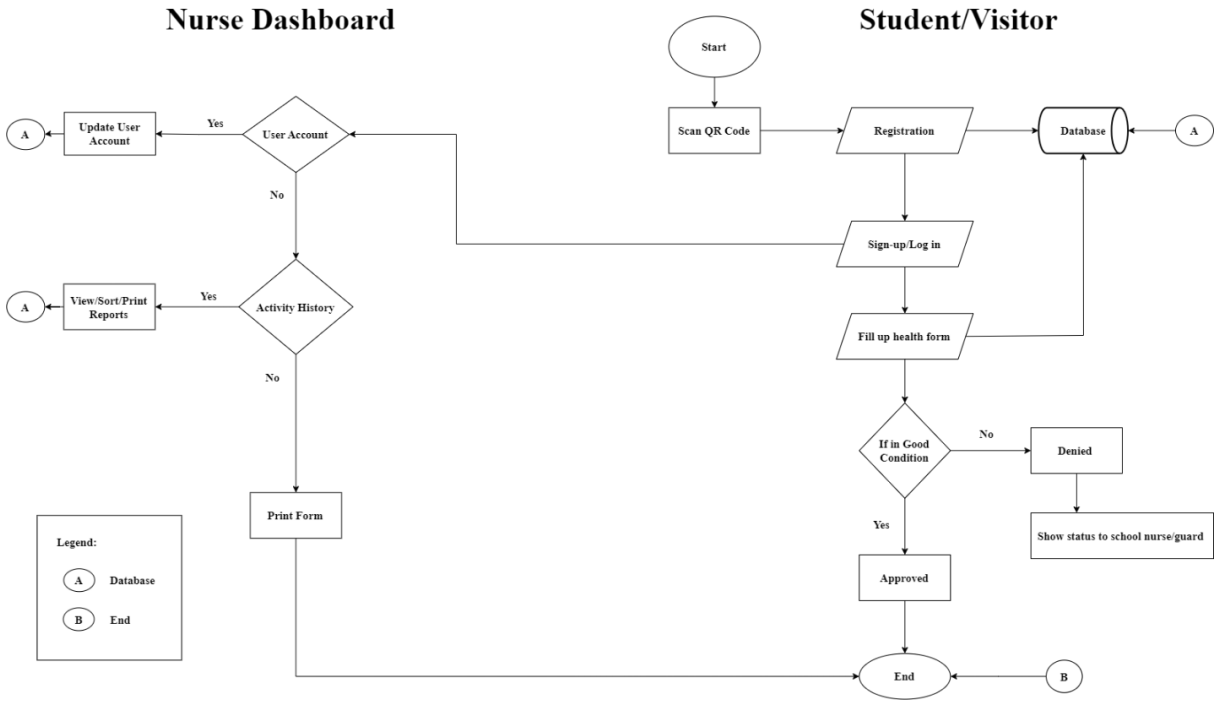


Figure 2. System Flowchart

The student will first scan a QR code, which will direct them to a landing page where they may log in or sign up. Input data will be saved in a database. Afterward, the student will complete a health questionnaire. The system will assess and then determine whether the student is with or without COVID-19 symptoms and if they be granted entrance to the school premises. The dashboard will be accessed by the nurse and will produce consolidated reports.

System Flowchart

The operation of the system will begin once a student scans the QR code on the school gate (Fig. 2). When the student scans the QR code, it will direct them to a landing page where they have the option to log in or register. If the student meets all of the registration requirements it will be saved in the database (Fig. 3); however, if the student fails to meet the requirements, the student's registration will be automatically rejected. The student will then complete a health checklist form every time they are to enter the campus, and the data will be saved again in a database (Fig. 4). The system will assess whether the student passed the health form. If yes, the student will be accepted and permitted to physically attend classes; if not, the student will be informed with a status on his or her screen that he or she is in bad condition thus prohibiting him or her from entering the school.

#	Name	Type	Collation	Attributes	Null	Default	Comments	Extra	Action
1	id	int(11)			No	None		AUTO_INCREMENT	Change Drop More
2	fname	varchar(255)	utf8mb4_general_ci		No	None			Change Drop More
3	mname	varchar(255)	utf8mb4_general_ci		No	None			Change Drop More
4	lname	varchar(255)	utf8mb4_general_ci		No	None			Change Drop More
5	gender	varchar(255)	utf8mb4_general_ci		No	None			Change Drop More
6	bday	date			No	None			Change Drop More
7	course	varchar(255)	utf8mb4_general_ci		No	None			Change Drop More
8	pnumber	varchar(255)	utf8mb4_general_ci		No	None			Change Drop More
9	address	varchar(255)	utf8mb4_general_ci		No	None			Change Drop More
10	email	varchar(255)	utf8mb4_general_ci		No	None			Change Drop More
11	vcard	varchar(255)	utf8mb4_general_ci		No	None			Change Drop More
12	regform	varchar(255)	utf8mb4_general_ci		No	None			Change Drop More
13	username	varchar(255)	utf8mb4_general_ci		No	None			Change Drop More
14	password	varchar(255)	utf8mb4_general_ci		No	None			Change Drop More
15	usertype	varchar(255)	utf8mb4_general_ci		No	None			Change Drop More

Figure 3. Tbl Registration

#	Name	Type	Collation	Attributes	Null	Default	Comments	Extra	Action
1	id	int(11)			No	None		AUTO_INCREMENT	Change Drop More
2	username	varchar(255)	utf8mb4_general_ci		No	None			Change Drop More
3	time	datetime			No	None			Change Drop More
4	temp	varchar(255)	utf8mb4_general_ci		No	None			Change Drop More
5	place	varchar(255)	utf8mb4_general_ci		No	None			Change Drop More
6	reason	varchar(255)	utf8mb4_general_ci		No	None			Change Drop More
7	days	varchar(255)	utf8mb4_general_ci		No	None			Change Drop More
8	household	varchar(255)	utf8mb4_general_ci		No	None			Change Drop More
9	fever	varchar(255)	utf8mb4_general_ci		No	None			Change Drop More
10	ubo	varchar(255)	utf8mb4_general_ci		No	None			Change Drop More
11	headache	varchar(255)	utf8mb4_general_ci		No	None			Change Drop More
12	cold	varchar(255)	utf8mb4_general_ci		No	None			Change Drop More
13	vomit	varchar(255)	utf8mb4_general_ci		No	None			Change Drop More
14	diar	varchar(255)	utf8mb4_general_ci		No	None			Change Drop More
15	fever1	varchar(255)	utf8mb4_general_ci		No	None			Change Drop More
16	sore	varchar(255)	utf8mb4_general_ci		No	None			Change Drop More
17	body	varchar(255)	utf8mb4_general_ci		No	None			Change Drop More
18	taste	varchar(255)	utf8mb4_general_ci		No	None			Change Drop More
19	smell	varchar(255)	utf8mb4_general_ci		No	None			Change Drop More
20	wap	varchar(255)	utf8mb4_general_ci		No	None			Change Drop More
21	fat	varchar(255)	utf8mb4_general_ci		No	None			Change Drop More
22	status	varchar(255)	utf8mb4_general_ci		No	None			Change Drop More

Figure 4. Tbl Hform

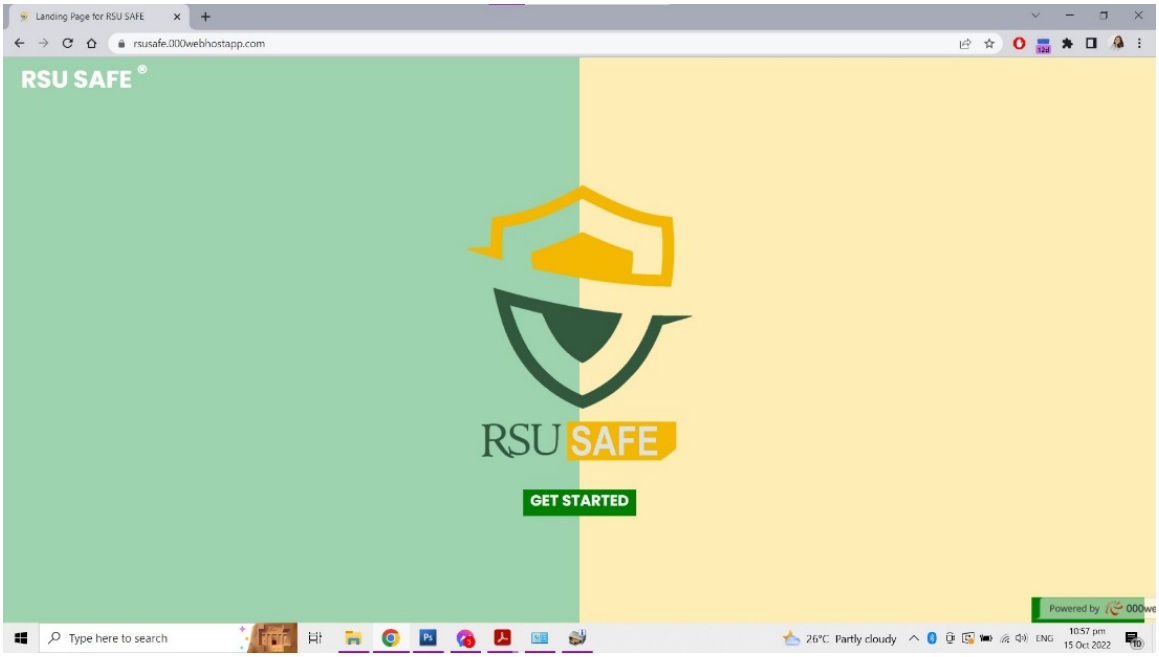


Figure 5. RSUSafe Website Graphic User Interface (Web Version)

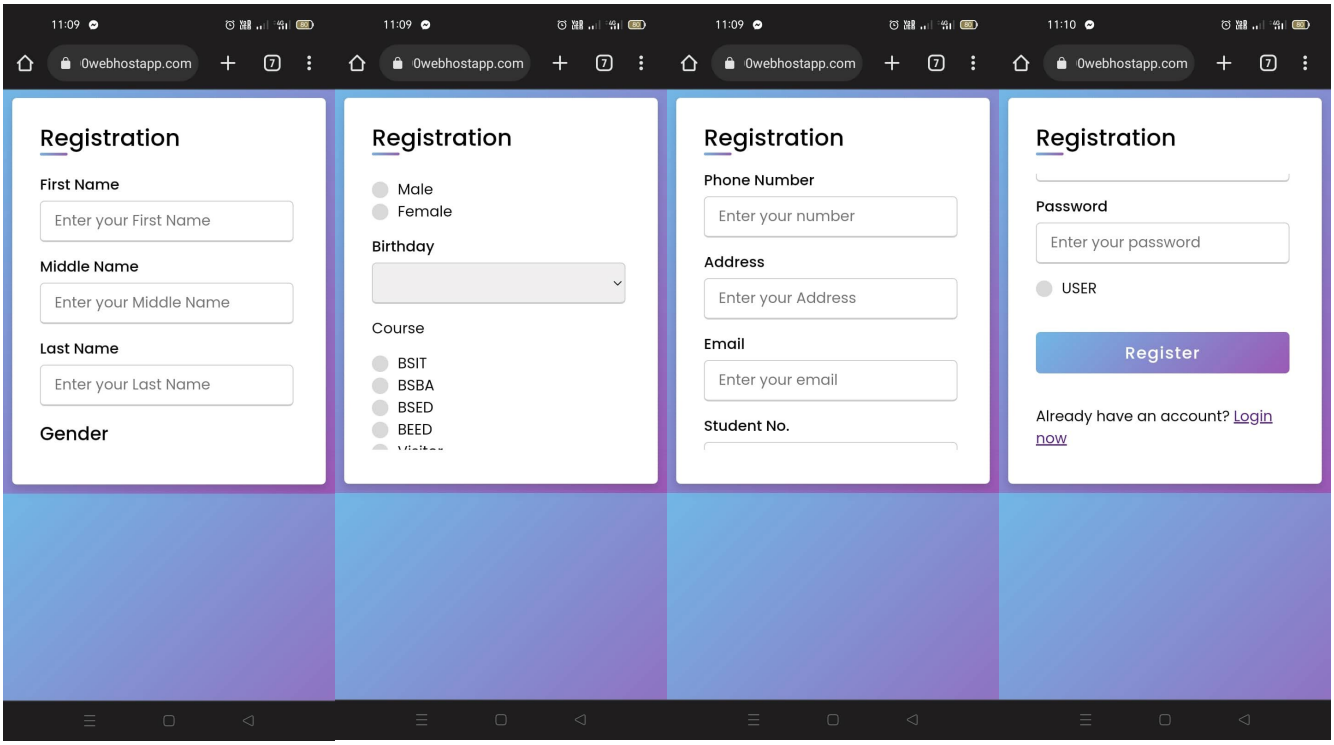


Figure 6. Registration

Romblon State University Research Journal
ISSN: 2619-7529 (Online) | ISSN: 2350-8183 (Print)
Volume 5 (2): 24-32, 2023

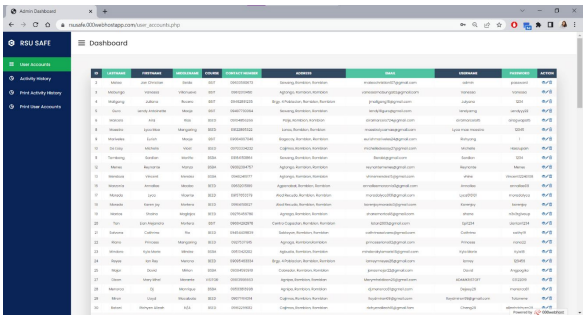


Figure 7.A. Dashboard of User Accounts

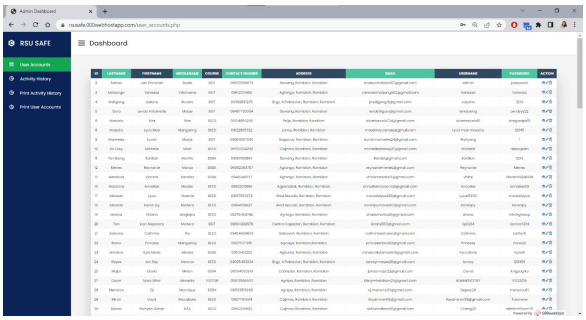


Figure 7.B. Dashboard of Activity History

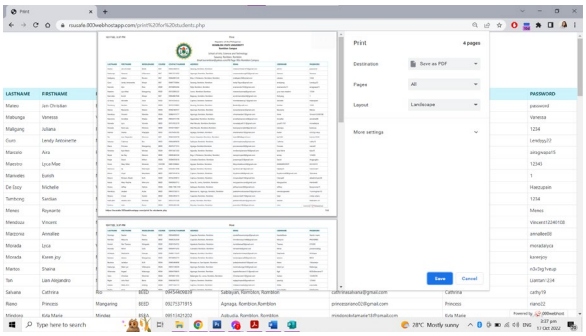


Figure 7.C. Print User Account

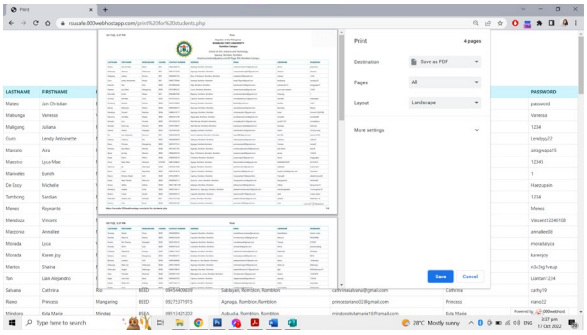


Figure 7.D. Print Activity HistoryPrint User Account

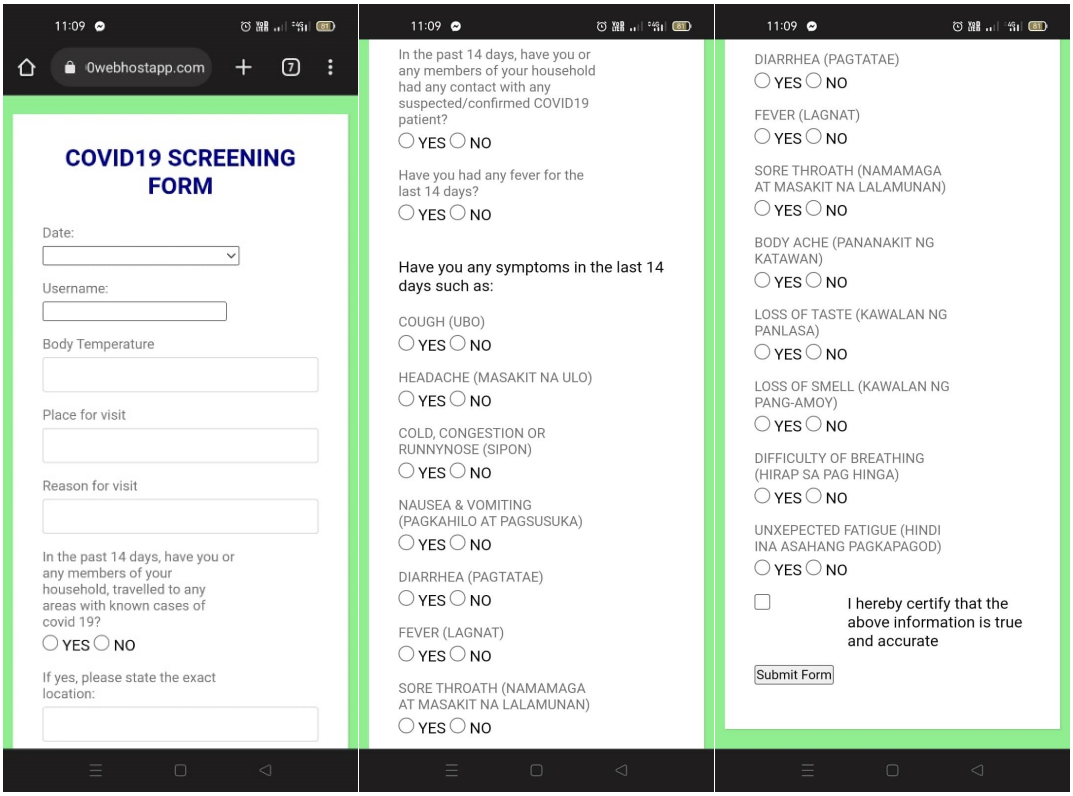


Figure 8. Health Form

Figure 9. QR Code

The nurse will also have an account to log in, where she can have access to the system's data. The dashboard will display all of the student's information and data. The administrator can sort and print the needed report from the database.

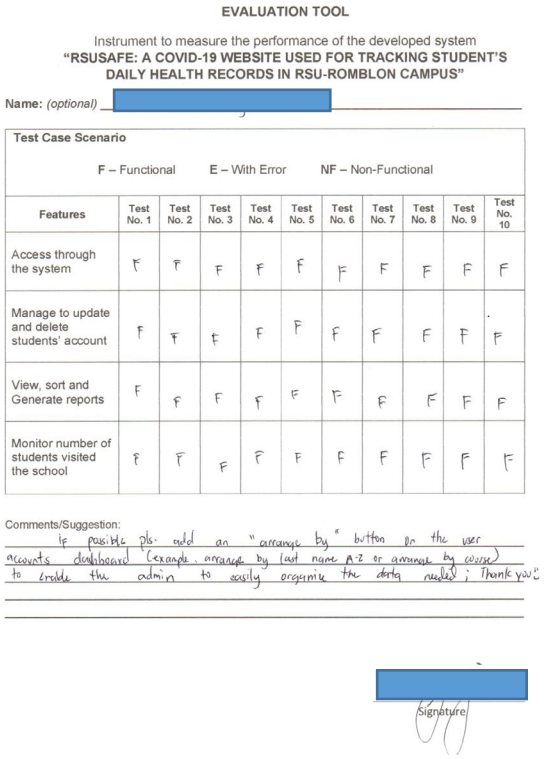
Software Development Tools

This study was designed to meet the desired needs and meet the requirements based on the analysis. Software Development Tools Coding was written and configuration was performed to network the software. The designed system was deployed on a server for a series of real user tests. Functional testing was conducted and users were trained to operate the system. At this stage, the researchers looked at the actual functionality of the website. It underwent continuous development, functional testing, and continuous revisions.

The hardware specifications were complied to ensure that the hardware infrastructure functions optimally during critical stages of system development and testing, contributing to the overall success of the developed system.

Study Participants

At the time of the study, RSU Romblon Campus had a total population of 1,960 students disaggregated per department as follows: Business Administration = 948 (444 males, 507 females); Education = 700 (193 males, 507 females); and Information Technology = 312 (207 males, 105 females). Twenty-five students from each department were chosen based on convenience sampling procedure due to time constraints and availability of students, making a total of 100 responses for the battery assessment. A survey using an evaluation tool was conducted to provide tangible information that would give a reliable and valid assessment of the system.


EVALUATION TOOL

Instrument to measure the performance of the developed system
"RSUSAFE: A COVID-19 WEBSITE USED FOR TRACKING STUDENT'S DAILY HEALTH RECORDS IN RSU-ROMBLON CAMPUS"

Name: *(optional)* [redacted]

Test Case Scenario

F – Functional E – With Error NF – Non-Functional

Features	Test No. 1	Test No. 2	Test No. 3	Test No. 4	Test No. 5	Test No. 6	Test No. 7	Test No. 8	Test No. 9	Test No. 10
Access through the system	F	F	F	F	F	F	F	F	F	F
Manage to update and delete students' account	F	F	F	F	F	F	F	F	F	F
View, sort and Generate reports	F	F	F	F	F	F	F	F	F	F
Monitor number of students visited the school	F	F	F	F	F	F	F	F	F	F

Comments/Suggestion:

if possible pls. add an "arrange by" button on the user accounts dashboard (example. arrange by last name A-Z or arrange by course) to enable the admin to easily organize the data needed ; thank you!

[redacted]

Signature

Figure 10. Nurse's Acceptability Evaluation Tool

RESULTS AND DISCUSSION

One of the study's specific objectives is to develop a website that provides a user-friendly graphical user interface (GUI) for students. This feature of the system may look different depending on the end user for whom the product is designed, and in the case of this website, the clients are students. Thus, even if this website offers numerous advanced features, the researchers made it possible to produce and make it user-friendly by designing a simple, clean, and intuitive interface. This is due to the reason that the researchers were gearing towards user-friendly GUIs because these are typically more successful than those with complex, convoluted interfaces that are difficult to use. Moreover, clients and end-users often avoid unreliable products, such as software programs that are full of bugs. The screen-capped version of the website's user interface is presented in Figure 6.

The website offers an easy-to-navigate system wherein students will be easily directed to where they clicked. For example, both in the desktop and phone versions, the respondents will see a 'Get Started' button which takes them to the login screen of the website. Presented on the login screen is the fill-out box where the end-user and the administrator will input their username and password to access the site. After logging in, the website for the end-users will proceed to the

completion of the health form for health status assessment which is shown in Figure 8.

As for the administrator, after logging in, the site will automatically redirect to the dashboard wherein students' information and activity history are provided and presented. To justify the website's feature of offering a user-friendly GUI, icons and buttons can be easily clicked and navigated as presented in the aforementioned figures in the study.

Aside from the goal of providing a user-friendly interface, the website aimed to craft a digital health record that has the capability of tracking the daily health status of students who will participate in the flexible in-person classes. The screen-capped version of one of this website's features- digital recording has been presented (Figs. 7A-7B).

Simply put, contact tracing is a system used to slow the spread of infectious diseases like coronavirus. Numerous processes are needed in order to perform successful health tracing especially during this trying times. But these manual daily health tracking is very time-consuming. Hence, in order to cut down on the manpower needed to manage these processes, a wide array of digital tools is surfacing around the world. As shown in Figures 8A-8C, the website offers an ease of work for the university nurse in monitoring the ins and outs of the student as well as their daily health status. In addition, the website is considered to be a key dimension of the institution's strategy as it moves towards the goal of reducing instances of contact when the virus is passed on while people are asymptomatic. Tracking the daily health status of students in RSUSafe website involves numerous data that is vital to health assessment. It includes the following: (1) health form provided by the school nurse; (2) basic symptom assessment e.g. fever, cough, cold etc. (3) temperature of the student before entering the school premises.

One more feature of the website is generating a Quick Response "QR" Code (Fig. 9). RSUSafe website has its own generated QR code for students to use when accessing the website. Aside from the ease of using and the convenience of using mobile devices to scan QR codes, students which are the end-users were drawn to perceived exclusivity. The QR code that is provided for students to scan is made only for Romblon State University- Romblon Campus so that the data will remain intact in one institution. Besides that, QR codes provide the affluence of just scanning and redirecting to the website in an instant rather than typing lengthy words just to access the website.

Besides developing advance yet easily understood features, another key goal of this research is to produce adequate reports. Printing consolidated, accurate, and reliable result can be seen on dashboard and is easily accessible to the school nurse for compiling and recording (Figs. 7C-7D).

The admin's point of view contains basic information of the students – last name, first name, middle name, course, contact number, address, email, username, password; and an action key to either delete it or not. The activity history of students entering the school facilities is also tracked. This is an option which is controlled by the administrator of the website which in this case is the school nurse. The information contained in the dashboard were as follows: last name, first name, middle name, course, contact number, address, temperature, place to visit, reason to visit, date of visit, and the status of the student whether approved or denied. This information is made available for the nurse to be able to monitor each student's health before entering the school premises.

Figures 7C-7D, provide adequate data including printable report which can be compiled by the school nurse in order to produce daily, monthly, and weekly assessment of students' health status. Further, adequate or complete data contains (1) full name of student; (2) program taken; (3) contact details and address; (4) date and place to visit; and (5) remarks if the student is in a good condition or not. The website was assessed and evaluated by the school nurse to ensure that the system really produced adequate reports (Fig. 11).

Figure 10 presents the result of the nurse's acceptability evaluation of the website. The given statistical tool was based on ISO 25010:2011 standards wherein every feature of the application should adhere to the quality provided by the said standardization tool before allowing end-users to utilize it. All tests presented were given a "Functional" rating by the school nurse which will serve as the administrator of the website. The website is deemed efficient based on the ratings of the nurse.

The last specific objective of the study was to test the acceptability of the system using ISO 25010:2011 standard. International Organization for Standardization 25010:2011 is labelled as systems and software engineering. It is used as a quality model composed of five characteristics wherein some of which are further minimized into sub-characteristics that relate to the outcome of interaction when a product is used in a particular context. The following are the aspects of the system subjected for acceptability test: (1) Functional Suitability, (2) Performance Efficiency, (3) Reliability, and (4) Security. Data were gathered after the respondents used and evaluated the system.

Table 1 shows the result on the Software Evaluation for the performance of the RSUSafe System under functional suitability. Results showed that the system is highly suitable across functional completeness (M=4.67), functional correctness (M=4.55), and capacity (M=4.53). The overall mean for functional suitability was 4.58 indicating high functional suitability of the RSUSafe System.

Table 1. Functional Suitability of the RSUSafe System

Functional Suitability	SA (5)	A (4)	FA (3)	D (2)	SD (1)	Mean	Verbal Interpretation
1. Functional completeness	71	25	4	0	0	4.67	Highly Suitable
2. Functional correctness	60	35	5	0	0	4.55	Highly Suitable
3. Functional appropriateness	60	34	5	1	0	4.53	Highly Suitable
Mean						**4.58**	**Highly Suitable**

Table 2. Performance Efficiency of the RSUSafe System

Performance Efficiency	SA (5)	A (4)	FA (3)	D (2)	SD (1)	Mean	Verbal Interpretation
1. Time behavior	72	20	8	0	0	4.64	Highly Efficient
2. Resource utilization	73	23	3	1	0	4.68	Highly Efficient
3. Capacity	66	29	4	1	0	4.60	Highly Efficient
Mean						**4.68**	**Highly Efficient**

Table 3. Reliability of the RSUSafe System

Reliability	SA (5)	A (4)	FA (3)	D (2)	SD (1)	Mean	Verbal Interpretation
1. Maturity	49	47	3	1	0	4.44	Reliable
2. Availability	63	31	6	0	0	4.57	Highly Reliable
3. Recoverability	56	37	7	0	0	4.49	Reliable
Mean						**4.5**	**Highly Reliable**

Table 4. Security of the RSUSafe Sytem

Security	SA (5)	A (4)	FA (3)	D (2)	SD (1)	Mean	Verbal Interpretation
1. Confidentiality	64	30	6	0	0	4.58	Highly Secured
2. Integrity	62	34	4	0	0	4.58	Highly Secured
3. Accountability	64	32	3	0	1	4.58	Highly Secured
Mean						**4.58**	**Highly Secured**

Table 2 shows the result on the RSUSafe System in terms of performance efficiency. Results showed that the system is highly efficient across functional time behavior (M=4.64), resource utilization (M=4.68), and functional appropriateness (M=4.60). The overall mean was 4.68 indicating the system's high performance efficiency.

Shown in Table 3 are the evaluation results of the RSUSafe System for reliability. Findings showed that the reliability of the system ranged from reliable to highly reliable as in terms of its indicators such as maturity (M=4.44), availability (M=4.57), and recoverability (M=4.49). The overall mean was 4.50 implying that the system is highly reliable.

Table 4 shows the evaluation results of the RSUSafe System for its security features. Results showed that the system is highly secured in terms of its indicators such as confidentiality (M=4.58), integrity (M=4.58), and accountability (M=4.58). The overall mean was 4.58 implying that the system is highly secured.

In general, the result of the overall acceptability through ISO 25010:2011 suggests that the overall aspect of the system is ready for deployment and implementation. The website is suitable and ready for use in serving its purpose of tracking the daily health record of students in Romblon State University – Romblon Campus.

CONCLUSION AND RECOMMENDATIONS

The RSUSafe system was developed in order to track students' daily health records in Romblon State University- Romblon Campus. Further, data from users and filled-out health forms were recorded and stored in the database, which is reliable in generating the reports that depend upon the school nurse's choice of date. The admin could sort, add, and delete users' data and accounts. The website feasibly provided the following features: (1) a user-friendly GUI for students; (2) daily health status tracking; and (3) easily accessible QR code specific for Romblon Campus only. The system was developed acceptable to the students of RSU - Romblon Campus and evaluated using ISO 25010:2011 standards implying that the system is ready for deployment in RSU - Romblon Campus.

To future developers and adapters, this system may be developed through the addition of innovative features such as infrared technology to read the temperatures of the students and visitors and autofill the form when it is done. The current interface may also be enhanced such as the addition of visit history and making this available for the end-users to see, consultation booking and safe trace which contains accessing the current location of the students to track and trail down the places they entered around the university premises.

AUTHORS' CONTRIBUTIONS

Mindoro-Mesana serves as the teacher adviser while the rest of the authors are students for A.Y. 2023-2024.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

REFERENCES

Shereen, M. A., Khan, S., Kazmi, A., Bashir, N., & Siddique, R. (2020). COVID-19 infection: Emergence, transmission, and characteristics of human coronaviruses. *Journal of advanced research*, *24*, 91-98. https://doi.org/10.1016/j.jare.2020.03.005

Day, M. (2020). Covid-19: European officials warn that exiting lockdown will be" very long" and will require cooperation. *BMJ (Clinical Research ed.)*, *369*, m1549-m1549. https://doi.org/10.1136/bmj.m1549

Department of Education. (2020a, July 1). DepEd prepares Self-Learning Modules for education's new normal | Department of Education. *Department of Education*. https://www.deped.gov.ph/2020/07/02/deped-prepares-self-learning-modules-for-educations-new-normal/

Department of Education. (2020b, December 15). Official Statement on the Pilot Implementation of Limited Face-to-Face Classes | Department of Education. *Department of Education*. https://www.deped.gov.ph/2020/12/15/official-statement-on-the-pilot-implementation-of-limited-face-to-face-classes/

Department of Education. (2020c, December 26). On the recall of the President's approval of the pilot run of face-to-face classes | Department of Education. *Department of Education*. https://www.deped.gov.ph/2020/12/26/on-the-recall-of-the-presidents-approval-of-the-pilot-run-of-face-to-face-classes/#:~:text=December%2026%2C%202020%20%E2%80%93%20Secretary%20Leonor

Durrheim, D. N., Andrus, J. K., Tabassum, S., Bashour, H., Githanga, D., & Pfaff, G. (2021). A dangerous measles future looms beyond the COVID-19 pandemic. *Nature Medicine, 27*(3), 360-361. https://doi.org/10.1038/s41591-021-01237-5

Guo, Y.-R., Cao, Q.-D., Hong, Z.-S., Tan, Y.-Y., Chen, S.-D., Jin, H.-J., Tan, K.-S., Wang, D.-Y., & Yan, Y. (2020). The origin, transmission and clinical therapies on coronavirus disease 2019 (COVID-19) outbreak – an update on the status. Military *Medical Research, 7*(1). https://doi.org/10.1186/s40779-020-00240-0

Kleinman, R. A., & Merkel, C. (2020). Digital contact tracing for COVID-19. *Cmaj, 192*(24), E653-E656. https://doi.org/10.1503/cmaj.200922

Sarmiento, P. J. D., Sarmiento, C. L. T., & Tolentino, R. L. B. (2021). Face-to-face classes during COVID-19: A call for deliberate and well-planned school health protocols in the Philippine context. *Journal of Public Health, 43*(2). https://doi.org/10.1093/pubmed/fdab006

Tria, J. Z. (2020). The COVID-19 pandemic through the lens of education in the Philippines: The new normal. *International Journal of Pedagogical Development and Lifelong Learning, 1*(1), 2-4. https://doi.org/10.30935/ijpdll/8311

UNESCO. (2020, March 4). COVID-19 Educational Disruption and Response. *UNESCO*. https://en.unesco.org/covid19/educationresponse

Visual Studio Code. (2016, April 14). Visual Studio Code 1.0 Release. https://code.visualstudio.com/blogs/2016/04/14/vscode-1.0

Romblon State University Research Journal
ISSN: 2619-7529 (Online) | ISSN: 2350-8183 (Print)
Volume 5 (2): 33-39, 2023

Perceiving Highest Faculty Performance Using Classification Algorithms

Laarni R. Hellwig, Ella B. Paloma, and Aldren R. Rafol

ABSTRACT

The main objective of this study was to predict who among the faculty has the highest performance in terms of students' evaluation and head of the department (HOD) evaluation using data mining. The authors proposed three different classification techniques such as Decision tree, Naïve Bayes, and KNN algorithms. These were used to build classifier models that will determine the faculty performance. Their performances were compared over a dataset composed of responses of students and evaluation coming from the HOD using accuracy, precision, and recall. According to the results, the Nave Bayes classifier demonstrated the lowest accuracy over other classifiers that separate the most important variables, "Strongly Agree" and "Agree," with an accuracy of 91.67 percent based on student perception. This result can be a big help to the faculty and administration in decision making in what ways the faculty members can improve their performances where it is most needed.

Keywords: c*lassification algorithm, decision tree, HOD, KNN, Naïve Bayes, performance*

INTRODUCTION

The teachers' performance plays a critical role in the success of any educational establishment. Effective teaching methods adopted by teachers have a direct impact on student's academic performance and learning outcomes. Therefore, evaluating teachers' performance based on various factors such as academic background, teaching experience, and student feedback is crucial to improving teacher performance and ensuring the success of educational institutions. However, traditional methods of evaluating teachers' performance, such as classroom observations and self-evaluations, can be unreliable and subject to bias. To address this issue, modern tools such as data mining techniques can provide objective insights into teachers' performance, through identifying areas that require improvement and promoting fair and accurate evaluations.

According to Rafiei and Davari (2015), an individual's skills, knowledge, values, and behavior can influence their organizational performance, potentially leading to increased productivity. Training and development are seen as a long-term investment that can benefit organizations. In addition, Krenkel (2012) has stressed that a faculty member's performance is critical to achieving educational success, as their ability to implement effective strategies depends on their skills and competencies.

This study focuses on assessing the faculty's performance at Romblon State University-San Fernando Campus, specifically in instruction. While dean evaluations are used to evaluate faculty performance, it is also important to consider student feedback, which can play a vital role in tenure and promotion decisions. Therefore, this study aims to propose an enhanced evaluation method using data mining techniques to extract knowledge from student feedback and improve the evaluation process.

Data mining is a method of extracting knowledge from large amounts of data and can be applied in education to identify variables related to student learning processes. There are two types of data mining activities: predictive and descriptive. Predictive data mining uses classification and prediction to identify patterns and relationships that can aid in decision-making (Zourob & Maghari, 2017).

The decision tree algorithm is a widely used method for classification. It is a supervised learning algorithm that creates a tree-like structure model. The tree has nodes that represent attributes and branches that represent possible attribute values. The algorithm uses a divide-and-conquer approach to recursively divide data into smaller subsets based on the selected attribute until the data becomes homogeneous or the predefined

✉ lrrepilsibuyan@yahoo.com
Romblon State University – San Fernando Campus
Received 18 April 2022; Revised 17 May 2023; Accepted 14 December 2023

stopping criteria are met (Agaoglu, 2016). Mathematically, the decision tree algorithm can be represented as:

$$f(x) = \Sigma wi \times g\,(xi)$$

where *f(x)* is the predicted class label, *wi* is the weight assigned to the *i*th attribute, and *g(xi)* is the binary function that evaluates whether the attribute *xi* is true or false.

Another supervised data mining technique is the Naive Bayes method, which is a probability-based classification technique that calculates probability and produces output in the form of error prediction. The Naive Bayes algorithm assumes that the features are independent of each other, simplifying the computation of probabilities. The algorithm calculates the posterior probability of each class given the observed features and selects the class with the highest probability (Srivastava, 2012). Mathematically, the Naive Bayes algorithm can be represented as:

$$P(y|x) = P(x|y) \times \frac{P(y)}{P(x)}$$

where *P(y|x)* is the probability of class *y* given the observed features *x*, *P(x|y)* is the probability of observing the features *x* given class *y*, *P(y)* is the prior probability of class *y*, and *P(x)* is the marginal probability of observing the features *x*.

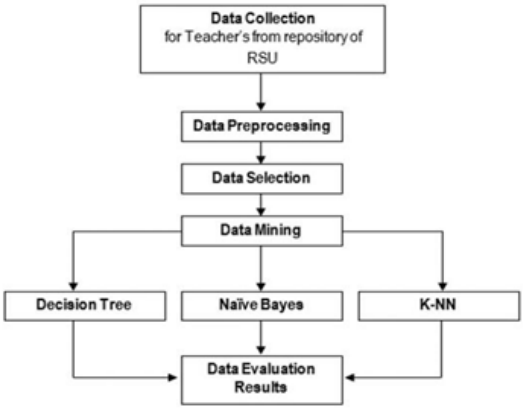


Figure 1. Overview of the steps for algorithms comparison

The K-NN Algorithm is a simple technique that records all available cases and categorizes new claims based on a similarity metric. It is a lazy learning algorithm that does not create a model but instead uses the training data directly to make predictions. The algorithm calculates the distance between the new observation and each observation in the training data and selects the *k* nearest neighbors based on the distance metric (Al-radaideh, 2012). The algorithm then assigns the class label that is most frequent among the *k* nearest neighbors to the new observation. Mathematically, the K-NN algorithm can be represented as:

$$y = mode\,\{yi|\, xi \in Nk(x)\}$$

where *y* is the predicted class label, the mode is the most frequent value of the class label, *Nk(x)* is the set of *k* nearest neighbors of the new observation *x*, and *xi* and *yi* are the feature vector and class label of the *i*th observation in the training data.

Teaching performance is considered an essential source of educational success, it is the ability to implement strategies effectively to achieve organizational plans. The implementation of the strategies relies on the skills of leaders and educators that have a direct impact on educational performance to achieve strategic goals.

The main objective of this document is to improve teacher performance through the assessment of students and heads of departments, specifically, experience and period of service. This could help determine teachers in need of improving their performance. The training, therefore, adds new information and knowledge to the experience and improves their performances in the classroom and in providing instructional materials to students, as well as how to manage time and use modern resources (Krenkel, 2012).

The said study proposed to use data mining techniques to evaluate teacher performance based on various factors. Data mining is an advanced tool for trying to analyze valuable information from statistical information, so the data needed for this study is already in the system. To address the shortcomings of traditional approaches, this study proposes an effective system model based on an algorithm for evaluating teachers' performance at Romblon State University, San Fernando Campus, San Fernando, Romblon. The goal of this study is to create a framework based on academic background, among other factors, that can be used to predict teachers' performance and recommend necessary actions for improvement (Dudhe & Sakhare, 2018).

METHODOLOGY

A data mining method was developed to approximate teacher performance at Romblon State University's San Fernando Campus in San Fernando, Romblon. The RapidMiner tool was used to apply three different classification algorithms (Decision Tree, Nave Bayes, and KNN) to the datasets. The steps involved data collection, data preprocessing, and data selection to assess most key attributes, data mining techniques for data classification, and finally results evaluation.

Table 1. Dataset attributes and description

Attributes	Description
Fac_Name	Faculty's Name
Bac_Degree	Bachelor's Degree of the Faculty
Master's_Degree	Master's Degree of the Faculty
Doctorate_Degree	Doctorate Degree of the Faculty
Academic_Rank	Rank of the Faculty
DOB	Birth date of the faculty
Age	Age of the faculty
FOS	The specialized field of the faculty
Designation	The faculty position
Department	The unit of the faculty
School_Name	The school name
Faculty_ID	ID of the faculty
Teaching_Experience	Years of teaching
Student's_Evaluation	Evaluation from students
HOD_Evaluation	Evaluation from the Head of the Department

Data Collection

The dataset used in this study contains information about experienced teachers' performance based on supervisors' evaluation, sourced from the data repository of Romblon State University. The data was stored in an EXCEL sheet and contains 42 records and 15 attributes (Hemaid & El-halees, 2015).

Data Pre-processing Data Cleaning

As part of the dataset preprocessing and to obtain better input data for data mining techniques, the authors performed some preprocessing on the collected data before loading it into the data mining software. Irrelevant attributes were removed as part of the dataset preprocessing process, to provide better input data for data mining techniques. To apply the data mining classifications to the attributes marked as selected in Table 2, data cleaning was used. Attributes such as the school's name and Employee ID were not included in the mining process because they would not provide any knowledge for the dataset processing and would reveal personal information about the teachers.

The steps were carried out as part of the dataset's preprocessing. The dataset's Supervised Evaluation attribute was chosen as the label.

Dataset Training and Testing

The data for this study was kept in a Microsoft Excel spreadsheet called "FACULTY.xls". The data was converted into CSV format for ease of use, resulting in the file "FACULTY.csv" (.csv extension).

Table 2. Sample Dataset attributes and their specification

Attributes	Description	Possible Value	Selected
Fac_Name	Faculty's Name	Nathanstee Q. Anayan	√
Bac_Degree	Bachelor's Degree of the Faculty	BSIT	√
Master's_Degree	Master's Degree of the Faculty	MICT	√
Doctorate_Degree	Doctorate Degree of the Faculty	DIT	√
Academic_Rank	Rank of the Faculty	Instructor 1	√
DOB	Birth date of the faculty	January 1, 1978	√
Age	Age of the faculty	42	√
FOS	The specialized field of the faculty	Information Technology	√
Designation	The faculty position	Research Coordinator	√
Department	The unit of the faculty	Technology	√
School_Name	The school name	-	
Faculty_ID	ID of the faculty	-	
Teaching_Experience	Years of teaching	25	√
Student's_Evaluation	Evaluation from students	Strongly Agree	√
HOD_Evaluation	Evaluation from the Head of the Department	4.56	√

RapidMiner was used to load the data and identify the attributes. Based on the methodology process, three classification algorithms were applied to the data set, namely Decision Tree, Nave Bayes, and KNN, and the data was split into 70% for training and 30% for testing.

Table 3. K-NN plot result

Algorithm	Accuracy	Class	Recall	Precision
Decision Tree	83.33%	Agree	83.33%	83.33%
		Strongly Agree	83.33%	83.33%
Naïve Bayes	91.67%	Agree	100.00%	85.71%
		Strongly Agree	83.33%	100.00%
K-NN	83.33%	Agree	66.67%	100.00%
		Strongly Agree	100.00%	75.00%

To ensure the quality and accuracy of the data, data preprocessing was carried out in RapidMiner after loading and identifying the data attributes. This involved handling missing values, eliminating duplicate records, and detecting outliers and anomalies.

The most relevant attributes for the classification task were then identified through data selection using feature selection algorithms such as information gain and correlation-based feature selection. The data was split into training and testing sets using a 70:30 ratio after selecting the relevant attributes.

The decision tree algorithm was used to generate a model from the training set. This model was then assessed using the testing set to measure its accuracy and performance. Similarly, the naive Bayes algorithm was applied to the training set to develop a probability model, which was then evaluated using the testing set.

Finally, the KNN algorithm was applied to the training set, and the number of neighbors (k) was optimized to achieve the highest accuracy. The optimized KNN model was then evaluated using the testing set to measure its accuracy and performance.

In summary, the simulation process included loading the data, performing data preprocessing, selecting relevant attributes, splitting the data into training and testing sets, applying three classification algorithms, and evaluating the results. The simulations were conducted in RapidMiner software, and the data was simulated to assess faculty performance in an educational setting.

RESULTS AND DISCUSSION

RapidMiner was used to create the proposed model. Three machine learning algorithms were used to create the model: Decision Tree, Nave Bayes, and KNN. Table 2 shows the results of a model comparison based on target attributes, accuracy, recall, and precision.

Figures 2-7 and Table 3 are the results of training and testing of the dataset where the three classifiers were applied.

The goal of the study was to propose an improved evaluation method using data mining techniques to extract knowledge from student feedback and enhance the faculty performance evaluation process at Romblon State University-San Fernando Campus. Three classification algorithms were used to classify faculty performance based on student feedback, namely Decision Tree, Naive Bayes, and KNN.

The results indicated that Naive Bayes had the highest accuracy rate at 91.67%, followed by Decision Tree at 83.33%, and KNN at 83.33%. Naive Bayes had

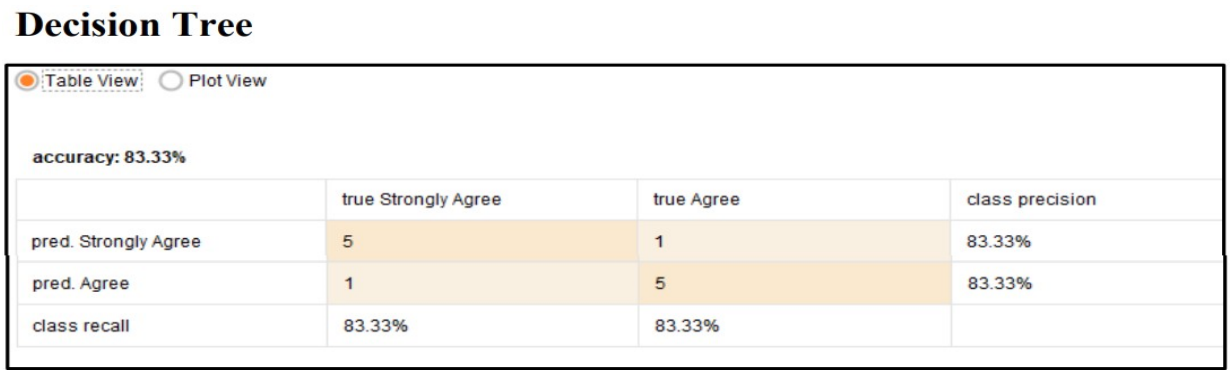


Figure 2. Decision Tree Performance

Romblon State University Research Journal
ISSN: 2619-7529 (Online) | ISSN: 2350-8183 (Print)
Volume 5 (2): 33-39, 2023

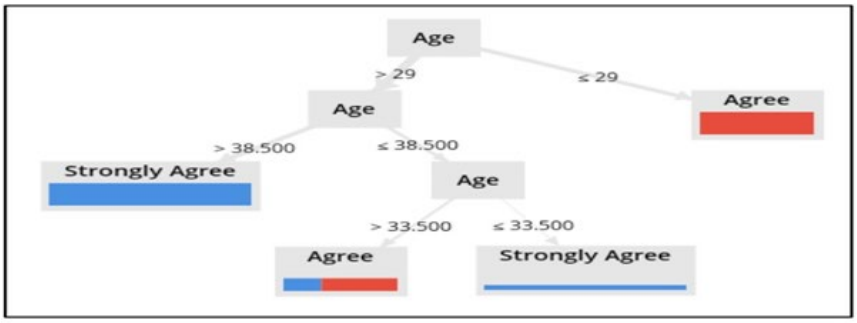


Figure 3. Decision Tree Graph

Table View Plot View

accuracy: 83.33%

	true Strongly Agree	true Agree	class precision
pred. Strongly Agree	5	1	83.33%
pred. Agree	1	5	83.33%
class recall	83.33%	83.33%	

Figure 4. Naïve Bayes Performance

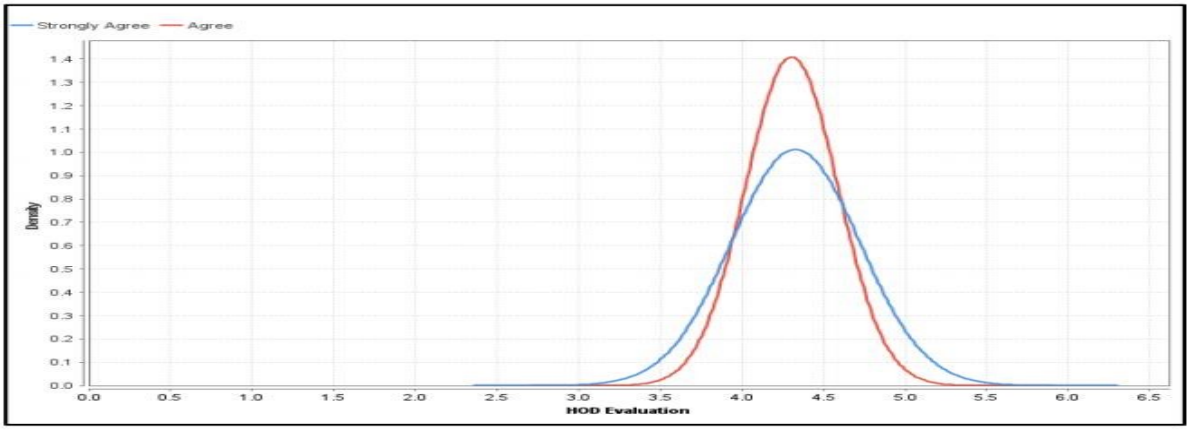


Figure 5. Naïve Bayes Result based on HOD Evaluation

Table View Plot View

accuracy: 91.67%

	true Strongly Agree	true Agree	class precision
pred. Strongly Agree	6	1	85.71%
pred. Agree	0	5	100.00%
class recall	100.00%	83.33%	

Figure 6. K-NN performance

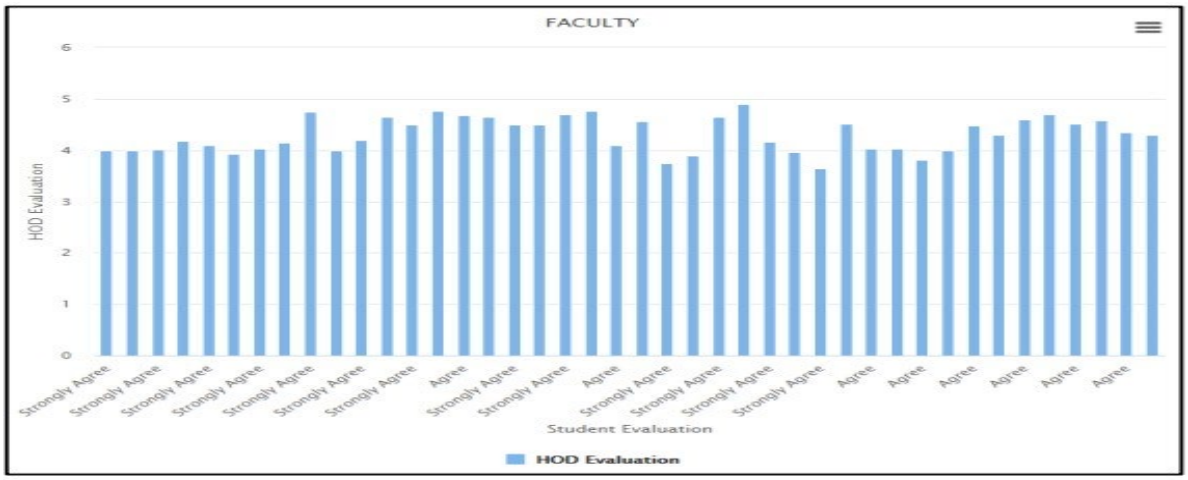


Figure 7. K-NN plot result

a 100% recall rate for the Agree classification and 83.33% for the Strongly Agree classification, while KNN had a 100% recall rate for the Strongly Agree classification and 66.67% for the Agree classification. Decision Tree had an 83.33% recall rate for both Agree and Strongly Agree classifications.

In terms of precision rate, Naive Bayes had a precision rate of 85.71% for the Agree classification and 100% for the Strongly Agree classification. KNN had a precision rate of 100% for the Agree classification and 75% for the Strongly Agree classification, while Decision Tree had a precision rate of 83.33% for both the Agree and Strongly Agree classifications.

The study's findings suggest that Naive Bayes was the most effective algorithm for classifying faculty performance based on student feedback. These results have implications for improving the evaluation process of faculty performance in higher education institutions and can aid in better decision-making regarding promotion and tenure decisions.

CONCLUSION

Data mining techniques once practiced particularly in higher education, provide a deeper insight into the educational and administrative challenges related to increasing the managerial effectiveness of teacher's performance. In this article, different classification algorithms were used to analyze the evaluation of students based on the performance of the teaching staff. Wherein the main variables that separate the performance of the teaching staff were "Strongly Agree" and "Agree" and were found based on student perception. Many attributes have been tested in performance work and some were effective in predicting performances. The student assessment and the department head assessment had a great impact on the teaching performance. In conclusion, the authors evaluated teacher performance using three algorithms: Decision Tree, Naïve Bayes and K-NN using the RapidMiner tool. Out of the three classification algorithms applied in the dataset, Naïve Bayes was the best in terms of accuracy, with 91.67% that outperformed other algorithms. These findings can help faculty improve their performances and develop more skills where they believe they need them most in the application of the best model from this study. In the future, it is recommended to collect more valid data from different departments where the problem related to students' learning preferences can be identified. The authors also recommend testing another classifier that at least replicates the popular algorithm used in this study, but also breaks those models informatively.

ACKNOWLEDGMENT

The authors would like to extend their heartfelt gratitude to the people who helped this study's success. To Dr. Emelia B. Ramos who helped check the manuscript. To Dr. Carmen J. Riva who provided the data of the faculty, and to all the respondents involved in this study.

AUTHORS' CONTRIBUTIONS

The planning of the study was initiated by LRH, EBP, and ARR. Responsible for data collection and extraction was EBP. ARR and EBP executed the preprocessing phase which was done through the RapidMiner tool. All of the authors contributed much to this study especially LRH who's the one responsible for the checking and formatting of the manuscript, EBP did some revisions and the conceptualization was done by ARR.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

REFERENCES

Agaoglu, M. (2016). Predicting instructor performance using data mining techniques in higher education. *IEEE Access, 4*, 2379-2387. https://doi.org/10.1109/ACCESS.2016.2568756

Al-Radaideh, Q. A., & Al Nagi, E. (2012). Using data mining techniques to build a classification model for predicting employees performance. *International Journal of Advanced Computer Science and Applications, 3*(2).

Dudhe, A. A., & Sakhare, S. R. (2018). Teacher ranking system to rank of teacher as per specific domain. *ICTACT Journal on Soft Computing, 8*(2). https://doi.org/10.21917/ijsc.2018.0222

Hemaid, R. K., & El-Halees, A. M. (2015). Improving teacher performance using data mining. *International Journal of Advanced Research in Computer and Communication Engineering, 4*(2), 407-412. https://doi.org/10.17148/IJARCCE.2015.4292

Krenkel, A., & Vasudevan, N. (2012). Performance management for faculty and staff. *University Business Executive Roundtable.*

Rafiei, N., & Davari, F. (2015). The role of human resources management on enhancing the teaching skills of faculty members. *Materia socio-medica, 27*(1), 35. https://doi.org/10.5455/msm.2014.27.35-38

Srivastava, J., & Srivastava, A. K. (2013). Data mining in education sector: a review. In *International Journal of Advanced Networking Applications, Special Conference Issue, National Conference on Current Research Trends in Cloud Computing & Big Data* (pp. 184-190).

Zoroub, M. K., & Maghari, A. Y. (2017, October). Candidate teacher performance prediction using classification techniques: a case study of high schools in Gaza-strip. In *2017 International Conference on Promising Electronic Technologies (ICPET)* (pp. 129-134). IEEE. https://doi.org/10.1109/ICPET.2017.30

ABOUT THE COVER

VISUAL ODE TO ECOLOGICAL DIVERSITY: The cover features a captivating scene of San Fernando, Romblon, with a meandering road gracefully navigating through the landscape, surrounded by lush greenery. The bend leads the viewer's gaze into the heart of the image. On one side, the landscape is adorned with vibrant flora; on the other, a tranquil water body complements the natural beauty. The composition underlines the romantic interplay between the winding road and the surrounding environment, accentuating the region's abundant natural resources. This visually compelling cover sets the stage for exploring San Fernando's ecological diversity and serves as a visual ode to the picturesque charm of the location.

Kenneth Dave Castillon/RDI IT Support Staff

RESEARCH • EXTENSION • DEVELOPMENT • INNOVATION

Research, Extension, Development and Innovation
Romblon State University
Odiongan, Romblon