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ABOMICS: An Automated Body Mass Index Computing System Applied on Learning Institutions

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ABSTRACT: The present study developed and evaluated an Automated Body Mass Index Computing System applied on Learning Institutions which allows measuring of height, weight, and BMI by user which improve the current conventional way of assessing BMI.Body Mass Index or BMI measurement is a vital section of the assessment of students' health in every learning institution. Similarly, the system measures individual's blood pressure, pulse rate, and temperature in less than two minutes. The database has added to the system so users can use stored information for future references and monitoring. It has been assessed and evaluated by experts in terms of acceptability, maintainability, portability usability, reliability, and functionality and was found to hit the mark. Likewise, it was favorably compared to the manual process done at the clinics of learning institutions. The study was able to solve the problems presented and achieve its objectives. The health staffs in public schools recommend adding respiratory rate for the next studies to complete the vital records of students and to use lighter materials for the frame of the system for portability purposes.

KEYWORDS:*Embedded Systems; Health Technology; Automation, Microcontroller, Body Mass Index*

1.0 INTRODUCTION

Evidently, people enjoy many advantages when they are healthy, foremost of which is feeling great and being able to achieve their task efficiently and effectively [1]. In

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particular, it is young people, the students, who have many activities and more workloads that require energy. By being healthy, they gain knowledge, enhance their skills, and do excellent work which is of value to others and which earns for them admiration and praise.

To safeguard students' health, schools follow guidelines, policies and standards which are mandated by the Commission on Higher Education (CHED) and Department of Education (DepEd). One of the provisions in learning institution is dental and medical treatment rendered by the health services. As [2] stated in 2009, "Trained personnel and adequate facilities must be present to afford students vital health services: like a) periodic physical and medical examination; b) periodic immunization; c) dental and medical treatment; d) treatment for common emergencies; and 5) counseling and guidance." Public schoolsmay be lack of facilities and equipment for health services [11]. Department of Education (DepEd) sends its registered nurses to public schools to render health assistance. But these nurses inevitably fail to submit on time their reports on schools they visit because of the sheer numbers of students and employees to be assessed. Private schools may be better equipped in providing dental, medical services and guidance counseling to its employees and students[12].

Once or twice a school year, public schools and private school clinics hold general medical check-ups to students enrolled [10]. In this check-up, the nurse evaluates the students' body height and weight, checks blood pressure and pulse rate and manually record the data. Height and weight measurement are needed to compute the body mass index (BMI) after which the student sees the school physician to discuss the results. Getting the BMI is essential since it gives clues on a person's health condition [3]. The result is used to find a person's category in an index of obesity or BMI chart. Other than BMI, getting blood pressure and pulse rate are basic functions needed in assessing the students' general health [4].

Nurses assigned to schools with different set ups face problems in the procedure of assessing students' health conditions. They have to assess so many students and worse, all procedures are done manually. The conventional way of using height chart and weighing scale would still pose a problem because so many students must be assessed.

A project named Body Mass Index calculator which shows the result on a LCD screen. The used of the height and weight measuring device is to send the data collected to the microcontroller as an input components and to calculate the BMI [5]. It has database for record keeping but this project intended for BMI only, no other measuring device except for height and weight and solve the BMI. Another device used in measuring the BMI is the limited edition of vending machine in a drugstore which offers individual's

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measurements of height, weight, Body Mass Index (BMI), and blood pressure and it will just take the user less than five minutes to measure everything. After all the measurements, the result will be issued and printed on a thermal paper. It gives the measurements, the percentage and normal range[6], but it has no database or record keeping of results.

To address this problem, the researchers came up with a study entitled ABOMICS: An Automated Body Mass Index (BMI) Computing System applied on Learning Institutions. The device will automatically take the body height and weight then calculate BMI. It will also measure heart beat rate, temperature, blood pressure, and record them directly into computer system (database). The technology-based method of assessing, adding, updating and archiving of student health records is deemed an improvement over the existing system and manual process.

The objective of the study is to developand evaluate an Automated BMI Computing System Applied on Learning Institutions.Specifically,the study aimed to improve the existing system employed by health clinics in learning institutions that can automatically detect body height and weight (for BMI) including temperature, pulse rate, blood pressure and to assess the acceptability, maintainability, portability, usability, reliability and functionality of the developed system considerably based to ISO/IEC 9126.

2.0METHODOLOGY

The researchers used methods to offer appropriate solution to the problems inherent in the existing system. According to [7], developmental research tends to enhance the credibility of the research, but it often creates methodological dilemmas for the researcher. Developmental research is often structured in phases. For example, comprehensive studies may consist of analysis, design, development, try-out and evaluation phase [7]. It aims to solve problems concerning advancing technologies or processes. Here, the project is relevant and the object of the research is clearly not knowledge in the theoretical sense but knowledge that practitioners can apply.

In the modern world of software developments many techniques need to be carefully considered to get the most out of it. A particular method known to maximize benefits of software development follows a system development lifecycles, which define an approach to be followed for each stage of the system's life.
According to [7], the agile software development methodology has recently become one of the most commonly used software development techniques. This helps produce a system of high quality because it enables the customer to fully understand and identify all requirements in the software project planning phase. The agile model is a

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combination of iterative and incremental process models which focus on process adaptability and customer satisfaction through speedy delivery of functional software. Every iteration or repetition involves cross functional teams working simultaneously on planning, requirements analysis, design, coding/building, unit testing, and acceptance testing. At the end of the iteration, the project is displayed to the customer or end user.

2.1 Population and Sample of the Study

The respondents of the study, the nurses, and personnel in charge of health service, health staff, and administrator were selected purposively. The researchers used purposive sampling technique in determining the number of respondents to ensure the validity and acceptability of the research.

Table 1. Respondents of the Developed System

Respondents	Profession	Position/Expertise
1	Registered Nurse	Dep.Ed. Health Staff
2	Registered Nurse	Private Health Staff
3	Registered Nurse	Private Health Staff
4	Registered Nurse	Private Health Staff
5	Registered Nurse	Head Nurse
6	Registered Nurse	Research Head
7	Licensed Teacher	School Principal
8	Licensed Teacher	Principal
9	IT	College Instructor
10	IT	College Instructor
11	Computer Engineer	College Instructor
12	Electronics Engineer	CEO

To insure that sound judgment was applied and to guarantee the performance of the developed device, the researchers requested the assistance of four computer and electronics-related professionals five nurses, and three school heads. Nurses were from public and private schools. Tapped were a computer engineer and two information technology specialists who taught in college and an electronics engineer. Table 1

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presents the list of evaluators of the developed device.

2.2 Data Collection and Instrument

After the research problem had been established, the researcher undertook to gather data for the study. They sent a formal letter to the administrator of the institutions asking permission to administer interview with the respondents. They personally delivered the consent form to each of the respondents who would participate in the study voluntarily.The researchers gave them a questionnaire guide before the actual interview and oriented them on the objectives of the research. All wrote their answers to the interview guide questions before the actual interview. In data gathering of this kind, saturation of methods was employed to insure quality and sufficiency of data obtained.

Before the implementation of the developed system, the respondents were requested to evaluate it using the criteria listed on the evaluation sheet. To start the evaluation, the researcher pilot tested the overall operation of proposed system in the presence of respondents. Afterwards, the respondents rated the system on a scale of 1 to 4, indicating their level of agreement to each statement.This accomplished, the researcher tallied the accumulated data from all the participants' evaluation to assess the functionality, reliability, usability, portability, maintainability and acceptability instead of efficiency of the developed system.

Data processing involved the input, throughput and output mechanisms. The inputs are the responses obtained from the research instruments. The throughput includes the statistical procedures and techniques used for the evaluation. In the evaluation, data were given numerical equivalents to facilitate tabulation. And for the last step, data were tabulated by tallying and counting the raw data to arrive at a frequency distribution and to organize them systematically using a table. The researcher also used comparison table to test the output of the system versus the manual process efficiency. He also used percentage error to compare the two outputs.

After the evaluation of the respondents, the researcher analyzed the data using statistical tests such as computing for the weighted mean and interpreted the data to determine the level of functionality, reliability, usability, portability, maintainability and acceptability of the system.

Lastly, to understand the meaning of the computed weighted mean, corresponding verbal interpretations were divided into four: A weighted mean of 3.5 to 4.0 means "Strongly Agree" which means that the respondents really believe that the developed

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system is very acceptable and highly recommended. The range from 2.5 to 3.49 is equivalent to "Agree," which means that the respondents are satisfied with the output of the developed system and the device is acceptable. Mean of 1.5 to 2.49 means "Disagree" and respondents are skeptical about the developed system due to inconsistencies in certain areas of concern. With average of 1.0 to 1.49, verbal interpretation of "Strongly Disagree," respondents will issue an unfavorable verdict, that the developed system fails in many aspects and they strongly disagree to use it. These would be the interpretations to the ratings that the respondents would choose.

Self-constructed questionnaires that served as research instrument were distributed to the nurses and other respondents before the development of the system. The researchers crafted the questionnaire and it was validated by experts. They formulated guide questions regarding the processes and methods in the clinic in terms of BMI computation, record keeping and other concerns. The collected data were vital because they would form the features of the system. The researchers collected the profile of the participants to affirm and confirm for the record their qualifications to give data on the study. Questions concerned the practices at the clinic which were within their expertise and professional experience. The researchers themselves were also an instrument for data collection and data analysis in a qualitative research. This was because they must respond and adapt to the process of collecting and analyzing data, process all gathered data and interpret them accurately.

The questionnaire was composed of two parts --the participant's profile and formulated questions. The profile included the name, age, gender and position at the workplace. On the other hand, the evaluation table indicated the criteria based on the ISO 9126 model to assess the developed system [8].The said model defines the characteristics that a system must possess and was used to evaluate the system that created.The Likert scale was used to interpret answers, 1 being the lowest rating and 4 being the highest.

2.3 The design of a computing device that detects body height and weight including temperature, blood pressure and heart rate

In designing the automated computing device, was constructed based on the block diagram shown on Figure 1 which represents the concept of the whole system

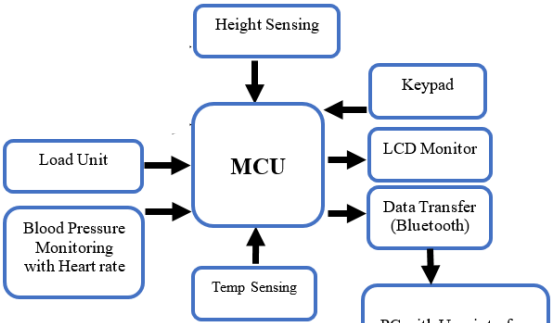

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Figure 1. Block Diagram of the Automated BMI Computing System

The Automated process needs the hardware and application interface for the user to login or create new account. If user exists, it can search student or employees; it can create or update records. If student or employee is already created, user can now get the vitals by pressing the buttons or keypad and be guided from the menu of the system visible in the LCD screen. It can also save record automatically or manually.

2.4 Creating the Automated Computing System that Automatically Calculates BMI

In creating the automated BMI computing system, the researchers considered several factors in order to ensure acceptability of the device. Such considerations involved the choice of materials/tools needed to build the system. These are ultrasonic sensor, load sensor, to automatically detect height and weight.The ultrasonic sensor measures distance based on sound travelled from the trigger of the sensor back to the echo. It is also known as ranging. To measure a distance through this ranging, an input of 10uS beat is applied to the trigger. Then, the module sends out an 8 cycle burst of ultrasound at 40 kHz [9]. PIC microcontroller receives data from weight and height sensor and produces computed BMI. It also receives the blood pressure reading, heart beat rate and temperature reading, and sends the output to the LCD monitor and to the computer through the use of Bluetooth module. Blood pressure monitoris used in the system, which also gets the heart beat rate. The researchers chose the upper arm blood pressure monitor instead of the wrist type because the upper arm is more accurate in reading than that taken from the wrist. Others are temperature sensor, button or switch and keypad.

These two sensors will supply the data to compute BMI. Height is transmuted in meters, while weight is expressed in kilograms. Personal information of the individual like age and genderis indicated. Following the formula given by the FNRI which is based on the World Health Organization (WHO) or with the given standard formula [13]:

BMI = [(Weight in Kilograms / (Height in Meters x Height in Meters)]

3.0 RESULT AND DISCUSSION

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Figure 2. Assembled Design

The hardware shown in the layout is composed of the frame, which supports the attached height sensor, and also the casing design (see Figure below). The last stage of the designing phase in hardware is the interface design/ screen layout which is composed of the initialization and the display of menu, with individual testing for blood pressure and heartbeat, temperature, weight and lastly the height. When you press the button at the bottom of the set, it will automatically and continuously take the measurements.

The functionality of the developed automated BMI computing system was tested on the basis of input and output. The researchers created a comparison table of the manual process versus the automated process, guided by registered nurses of staff involved in the health services of the school or personnel with expertise in the said field.

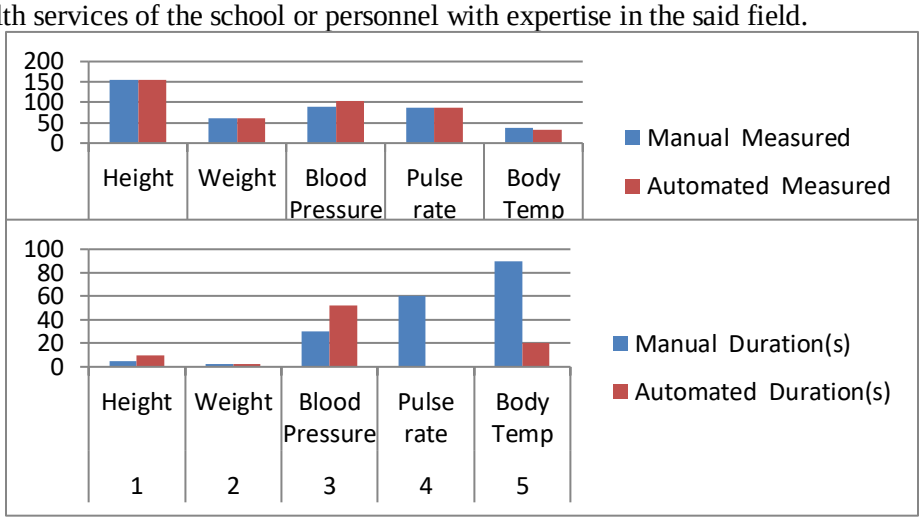

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Figure 3. Comparison of the Manual versus Automated Process -1

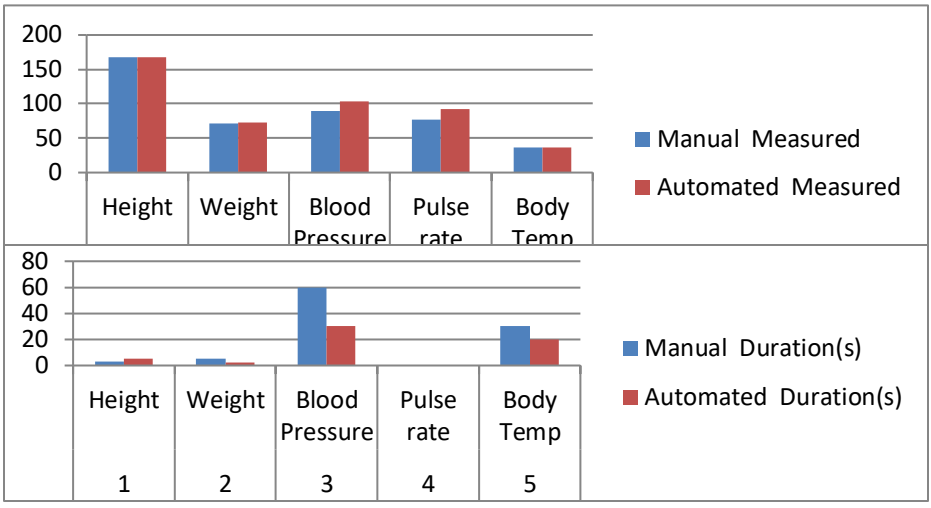

Figure 4. Comparison of the Manual versus Automated Process -2

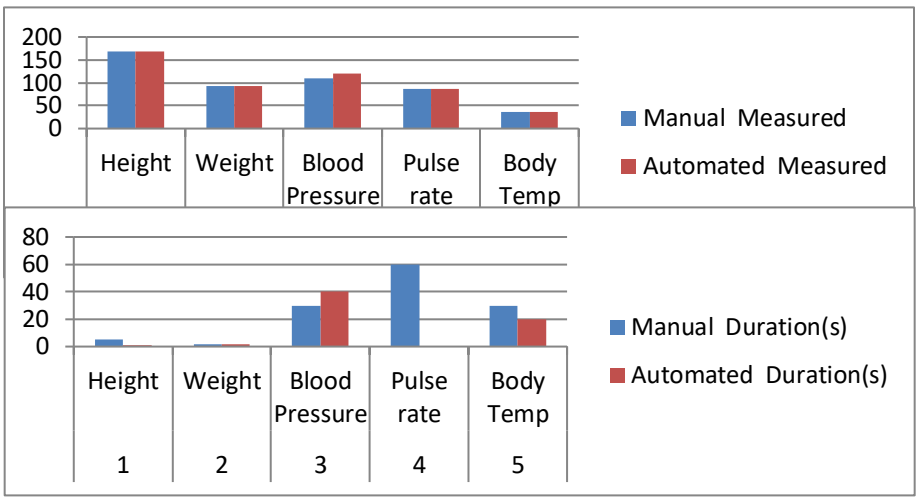

Figure 5. Comparison of the Manual versus Automated Process -3

The initial testing done by the researchers guided by a registered nurse and research head of a private institution showed a difference of one unit in height and pulse rate, and different output in blood pressure and body temperature. When it comes to the duration, the manual process took 187 seconds, while automated took 82 seconds only.In the testing done by the researcher guided by the school principal of a private institution infigure 4,one (1) unit difference in height measurement was seen. There

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was a slight difference and in the blood pressure, pulse rate, and weight and no difference in the body temperature. The manual process consumed 62 seconds while automated consumed 54 seconds.In the testing done by the researcher guided by the principal of a public school with the figure 5, one(1) unit difference in the weight measurement and body temperature was seen. There were different outputs in blood pressure, but same reading in pulse rate and height. The manual process took 127 seconds while automated process lasted 68 seconds.

For the evaluation, respondents were selected through purposive sampling since the researcher's objective was to test the acceptability of the device. Respondents were composed of nurses, school administrator, research head and teacher in charge in public and private schools, computer engineer and IT professionals because their expertise could definitely help in evaluating the developed system. Objectively, the instrument used in this study was based on ISO/IEC 9126. The four-point Likert scale was used to rate the functionality, usability, reliability, portability, maintainability, and acceptability of the device. The result of the evaluation was analyzed and interpreted using weighted mean. The overall rating was 3.69 which means the respondents "Strongly Agree" that the device is acceptable as an Automated BMI Computing System for Learning Institutions.

4.0 CONCLUSION

In view of the findings in this study, the researcher therefore concludes that the Automated Body Mass Index Computing System for Learning Institution is an improvement over the existing manual process. It can be used to help increase the efficiency of school clinics in data gathering and record management.

The developed system has been proven to be very acceptable in terms of functionality, usability, reliability, portability, maintainability, and acceptability as evaluated by the respondents. Like the manual process, it can be used to measure just one feature, or all features as required, but at a faster pace and more convenient set-up. The respondents were one in confirming that the automated computing system is very useful, and helpful as modern alternative to the operations in the clinic. Definitely, this will help ease the workload of DepEd nurses who will not have to tally and record information manually.

5.0 RECOMMENDATION

The following recommendations are based on the analysis and suggestions of the respondents as well as the researcher's point of view. These can be beneficial to the institution's clinic and staff which is more efficient in getting the BMI including body temperature, pulse rate, blood pressure and it is also beneficial to other researchers who intend to pursue the same field of interest and improve the Automated BMI

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Computing System. We humbly offer the following recommendations for consideration. (1) Consider other components to measure height and weight or more reliable mechanism to maximize the benefits of the research. (2) Implement a mobile application like Android and iOS platform. (3) Use more portable frame of the whole system for easier transport. Lastly, (4) Enhance the system by adding more features such as respiratory rate, which DepEd nurses use in assessing students' health condition (5) Since BMI does not measure body fat directly, and it does not account for age, sex, ethnicity, or muscle mass in adults, it is also recommended to integrate advance functionalities such as image processing and artificial intelligence for identifying age, sex, ethnicity or muscle mass.

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