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Development and Acceptability of the Mobile Workstation for Electronic Products Assembly and Servicing Training Program

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Abstract*: *The advancement of the Philippine Education System specifically the implementation of the new Philippine Qualification Framework which aims to address the challenges of the 4th Industrial Revolution and 21st-century education, necessitates that materials of instruction should be at par with 21st-century technologies. Thus, there is a need for teachers to be innovative and resourceful enough, and to develop instructional/training materials that will yield good effects on students. In the case of TESDA and the Senior High School TVL Track, workstations are in demand since it used to develop more competencies and give hands-on experiences to students. The primary objective of this study was to develop a Mobile Workstation for Electronic Products Assembly and Servicing (EPAS) NC II. It has specific objectives such as to make the design for the workstation; to identify the materials and procedures; and to evaluate its acceptability in terms of functionality, cost-effectiveness, safety, and workmanship. The Research and Development Process and Descriptive Method were used for the attainment of these objectives. Mean was used to compute the results of the evaluation of electronics Instructors and Assessor; private electronics practitioner; and students enrolled in Electronics Product Assembly Servicing NC II for the school year 2016-2017. The result of the evaluation of its acceptability showed that the workstation is highly acceptable with the over-all weighted mean of 4.79. It is recommended that this workstation should be used in the classroom and community-based training as instructional material for developing competencies in EPAS NC II. This can also be reproduced by TVET institutions and DepEd schools that offer EPAS NC II.

Keywords* : *4th Industrial Revolution, 21st Century Education, Mobile Workstation, Electronics Program

I. INTRODUCTION

The 4th Industrial Revolution, 21st-century education, and ASEAN integration open an opportunity to enhance the Philippine Education System. Now in the full implementation of K to 12 programs of DepEd, an additional two years in basic education is added to complete high school.

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The Senior High School offers different specialized tracks in Electronics Technology under Technical-Vocational and Livelihood (TVL). In the same way, the State Universities and Colleges (SUCs) supervised by the Commission on Higher Education (CHED) offer similar subjects in Electronics Technology and Engineering. The Camarines Sur Institute of Fisheries and Marines Sciences (CASIFMAS) a technical-vocational school supervised by Technical Education and Skills Development Authority (TESDA), a government agency mandated to manage and supervise technical education and skills development in the Philippines (R.A. 7796) [1] also offers similar program which is Electronics Products Assembly and Servicing (EPAS) NC II, a training designed for skills development of the trainees in the field of electronics.

In the 21-century learning, practical application of the theory is emphasized. The competency-based training (CBT) approach by TESDA to its TVET Programs stresses that the trainees engage in the practical work and perform different activities, and the approach should be individualized. CASIFMAS is a training institution supervised by TESDA that offers different courses that will develop the skills of the Trainees.

The EPAS NC II is one of the programs of TESDA-CASIFMAS focused on the skills development of the trainees in the field of electronics. Now, TESDA aims to reduce poverty through skills development. Community-based training is conducted not in the regular classroom set up but in common facilities such as barangay halls, barangay plaza, cover courts or any venues that the communities can easily access. These programs challenge the institution and the trainers to implement training that conforms to CBT since the training venue is not the regular classroom set up wherein all the materials needed in training delivery is already available.

The education sector always collaborates with industries to ensure its programs are suited to the needs of the industries. For the learning institutions to produce graduates who are equipped with knowledge, skills, and attitudes, they should conform to the needs of the industries and should acquire learning materials such as books, modules, equipment, simulators, and workstations to cater to the learning needs of the students so that they will be provided with meaningful experience. The practical application and the actual usage of devices are emphasized. In TESDA, competency-based training and - competency standard are implemented based on the needs of the industries.

It is a challenge to the Technical-Vocational Education and Training (TVET) institutions like CASIFMAS which offer electronics courses to acquire workstations that may provide the Trainees with knowledge and skills in electronics and give them more meaningful learning experience through the competency-based training in which actual industry practice is emphasized. Workstations are available in the market, however, they are quite expensive thus hinders TVET institutions to acquire them.

The need to develop competencies and the need for workstations inspired the researcher to design low-cost workstation that may be used to develop basic competencies for electronics. The design should be mobile, low cost, easy to construct, conforms to the CBT approach and the training regulation of EPAS NC II [2]. It can be used in community-based training. Thus, the researcher developed a workstation that has a complete modular set-up consisting of basic required apparatus needed in studying basic electronics. It was designed to be used as a training tool in skills development in the field of electronics particularly in EPAS NC II, assembling electronic products, circuit experimentation and instrumentations, troubleshooting and repair, and other related electronic practical activities. For safety, the workstation was designed with electronics and electrical safety provisions such as circuit breaker, emergency stop button, anti-static materials, and grounding system.

This project will serve as a workstation of the trainees for their laboratory activities since it contains the basic equipment and instruments needed for studying basic electronics. It can be used by TVET institutions and trainers in community-based training because of its mobile features.

Objectives of the Study

The main objective of this study was to develop a mobile workstation for Electronic Products Assembly and Servicing (EPAS) Training Program. Its specific objectives were the following: (1) to design a mobile; (2) to identify the materials and procedures in the assembly of the workstation; (3) to evaluate its acceptability as to its functionality, cost-effectiveness, safety, and workmanship.

II. METHODOLOGY

The study used the descriptive method and the Research and Development (R & D) process. The descriptive method was used to evaluate the acceptability level of the project, and to interpret the perceptions of the students/trainees, instructors/teachers teaching electronic subjects, Trainers/ Assessors and electronics practitioners. R & D was used for the design and development of the project. The steps of the process include *Planning and Designing, Construction, Initial Testing and Revision,* and *Final Testing and Evaluation.*

Planning and Designing

Planning and designing stage is the foundation of the study which includes the gathering of related literature and studies and other related information that are relevant to the design of the project. Several studies about workstations and instructional materials and different suggestions from experts were considered in the design of the project [3-10].

It is designed to be used as a mobile working area in EPAS NC II related activities. The 83cm X 40cm X 75cm workstation will be made of ¾ inch thick marine plywood as base and frame and divider of the workstation wherein the tools, instruments, and equipment will be installed as well as its electrical wiring and ½" marine plywood for doors. The workstation also has electronics and electrical safety provisions like a circuit breaker, an emergency stop button, an anti-static mat, and a wrist strap, and a grounding system.

The metal stand of the workstation is made of ½" and ¾" metal pipe. Using nuts and bolts the metal stand is connected to the wooden cabinet base of the workstation. The metal stand can be assembled and disassembled for easy storage. The height of the stand is 2 ft.

Construction

In this stage, the mobile workstation was constructed. The construction includes the following: fabrication of wooden cabinet and metal stand, electrical wiring installation, instruments and equipment installation, arrangement and fixing of soldering tools, cutting tools and driving tools, lighting system, exhaust fan, and drilling tool installation, and circuit integration. It also includes the pasting of labels for easy identification.

Initial Testing and Revision

In this stage, initial testing and revision were conducted to site particular defects of the workstation. The respective operation of instruments and equipment were tested as well as the stability of the workstation. After determining the defects and changes needed, revisions were done to achieve the desired output of the study.

Final Testing and Evaluation

In this stage, the project was subjected to the final testing and evaluation to determine the acceptability of the project in terms of functionality, cost-effectiveness, safety, and workmanship. The Mobile Workstation will be given to both students and experts for evaluation. The evaluators were thirty (30) experts composed of electronics trainer, assessor, instructors, and practitioner, and twenty (20) students from CASIFMAS enrolled in Electronics Product Assembly Servicing NC II, the students are enrolled in the school year 2016-2017. The primary instrument used in data gathering was a structured survey questionnaire. The respondents rated the project using the 5 point scale where 5 is interpreted as Very Acceptable; 4, Moderately Acceptable; 3, Acceptable; 2, Less Acceptable; and 1, Unacceptable.

Data Analysis and Statistical Tool

Average weighted mean was used in analyzing the data. All data will be treated using the computer programs of Microsoft Excel and Statistical Package for Social Sciences (SPSS).

III. RESULTS AND DISCUSSION

This chapter presents the details and the steps in the development of the Mobile Workstation for Basic Electronics from the conceptualization of its design, the identification of the materials, steps in the construction and assembly of the workstation. Likewise, it also includes the validation of the project in terms of functionality, cost-effectiveness, safety, and workmanship.

A. *Design of the Mobile Workstation for Basic Electronics*

The main objective in developing this project is to provide a mobile workstation to be used in Electronic Product Assembly Serving Training Program.

The workstation consists of two major parts: the wooden cabinet, and the metal stand. The wooden cabinet consists of an electrical system section, instruments and equipment divider, diagram board, sliding table with anti-static mat, tools and components compartment, and miscellaneous compartment. It is designed for easy access and convenient workplace.

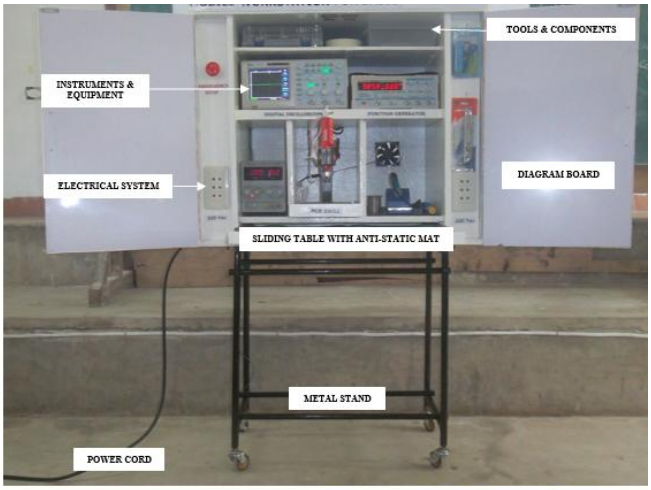

Figure 1. The Mobile Workstation for Basic Electronics

The cabinet is made up of 3/4 inch and 1/2 inch thick marine plywood with a dimension of 82 cm X 41 cm X 75 cm. For cabinet stability and rigidity a 3/4 in thick plywood was used as a frame and divider of the cabinet, while the doors are made of 1/2 in thick plywood for lighter features. The marine plywood was used for its durability.

The electrical system section is part of the wooden cabinet where the electrical wiring and electrical accessories are installed. From the power cord, an emergency push button is connected in series to a 220Vac, 15A circuit breaker used for overload protection. The convenient outlet is connected to the circuit breaker using heavy-duty duplex wire to supply power the entire workstation. The main electrical section is on the right side of the workstation.

The instruments and equipment divider is the section where the testing equipment and instruments are placed such as digital dc power supply, digital oscilloscope, digital function generator, PCB drill, and soldering tools. These equipment and instruments are the most basic requirements based on the training regulation of EPAS NCII. The divider is composed of three-layer, in the first layer, there are 3 sub-section for PCB drill, digital dc power supply and soldering section they are separated by 1/3" marine plywood. The PCB drill is installed on the 1/3" marine plywood with a drawer guide for easy access. It is located at the center of the first layer the for purpose is to provide the user enough space when drilling a copper printed circuit board and better accuracy of holes. At the right portion PCB drill, the digital dc power supply is placed here because when conducting circuit experiments the power supply terminal is often at the left portion of the circuitry. On the left side of the PCB drill, the soldering station wherein the soldering tools can be placed. It is located in the left portion of the first layer because most of the student is right-handed. And the right-handed person used their right hand when using soldering tools. The second layer is composed of a digital oscilloscope and a digital function generator. The digital oscilloscope is a testing instrument used to display signal while the function generator is used to the input signal on the circuit. They are located at the second layer which is in the eye level of the user and can interchange the position of two testing instruments it is based on the ergonomics design for visual display terminals. When reading signals it requires eye level position for reading accuracy and convenience. The third layer is for the storage of electronic tools and components. It has a tool and component box wherein the components can be placed. The digital trainer can be placed here when not in use.

The front door of the workstation is designed to be used as a diagram board or instruction/information board it is made of ½" marine plywood coated with plain white Formica. Once it opened it can be used as an information board wherein the diagrams and instruction or notes can be written.

The sliding table with an anti-static mat is a section specially designed as a working place where the user can make educational activities and practical works like troubleshooting and repair. The sliding table has an anti-static mat to avoid unwanted damage to the static sensitive components. It is designed like a drawer type and also used a drawer guide as support and easy storage. The table is free from static charges.

The miscellaneous compartment is a section used as storage for cutting tools, driving tools and other miscellaneous tools. The miscellaneous compartment is on the left side of the workstation.

The workstation is also equipped with an anti-static mat and anti-static wrist trap it is used to avoid the unexpected damage of electronic components especially to surface-mounted devices (SMD) and complementary metal-oxide-semiconductor (CMOS) due to static charge of the users. The equipment and instruments with metal cases such as the digital power supply and the function generator are connected to grounding wire as additional safety protection. A foldable lighting system clip type is also included in the design of the workstation for proper lighting. Two exhaust fans are installed at the back for ventilation of the workstation. A wooden cabinet is placed on the top of the medal stand.

The metal stand which is made of ½ in and ¾ in diameter metal pipe is designed for easy configuration and portability. The support ½" metal pipe is placed between the two stands for stability and used knots and bolts to easily assemble and disassemble the metal stand. Each stand is provided with a heavy-duty roller wheel with a lock for easy mobility of the workstation. The height of the stand including the wheels is 75 cm which is based on the standard height of the table.

Procedures and Materials

The ¾ in. marine plywood is used for the frame and compartments of the wooden cabinet. 1.5 in. and 2 in. nails and marine epoxy were used and applied for rigidity. For its doors, ½ in. marine plywood was used and connected to the cabinet using piano hinges. Polifuff was applied to every corner of the cabinet. Sandpapers were used to make it smooth. Two liters of white paint was applied to the cabinet to make it durable and presentable. The metal stand is made of ½ in diameter metal pipe; at the bottom roller wheels with lock were installed for mobility. The wooden cabinet and metal stands were fabricated by skilled workers.

The following are the general steps followed in the construction and assembly of the workstation:

Step 1: Fabrication of Wooden Cabinet, and Metal Stand;
Step 2: Fabrication of Wooden Cabinet, and Metal Stand;
Step 3: Installation of Circuit Breaker;
Step 4: Installation of Convenient Outlet;
Step 5: Installation of Emergency Push Button;
Step 6: Wiring and Installation of Outlet;
Step 7: Installation of Equipment and Instruments;
Step 8: Installation of anti-static materials and grounding wire;
Step 9: Placing the Digital Trainers, Tools and Components in the Drawers;
Step 10: Printing and Pasting of the Sticker Tags.

B. *Acceptability of the Mobile Workstation*

The overall rating of the project in terms of functionality is 4.78 interpreted as *very acceptable*. As perceived by both evaluators, the workstation can be used in Basic Electronics activities since it contains the most basic equipment and instruments needed for such activities. The workstation can also be used for troubleshooting and repair. The analog and digital multimeter are the most basic testing instruments for identifying the troubles of the devices. These are the major features considered by the experts and students in rating the workstation as very acceptable. In EPAS NC II one of the core competencies is the assembling electronic products in which the trainees design and fabricate a printed circuit board (PCB) and make functional designs. In the fabrication of the PCB especially in making holes for component terminals, PCB Drill is installed in the drawer guide for easy access and accuracy. Under this indicator, the rating of the students is quite lower than the experts but still *very acceptable*. In item number four, the workstation can be used in electronic circuit experimentation & instrumentation, the workstation is rated by both evaluators as *very acceptable* because of the digital trainer which is designed to be used for electronic circuit experimentation and instrumentation serves its purpose. The workstation includes high-quality digital oscilloscope, a digital function generator, and a digital multimeter. The expert evaluators observed the trainees working with the projects and saw that the equipment and instruments are properly functioning. The evaluators rated the functionality of the equipment and instruments almost perfect with the rating is 5, while the students rated it 4.9 which is still *very acceptable.*

For cost-effectiveness, the materials used in the project were rated 5 by the experts because of their availability in the local market; the students' rating, however, is 4.8, bit lower than the experts' rating. As regards the cost and the quality of the materials used the experts gave a rating of 4.6 interpreted as *very acceptable*. The experts knew that the price of materials is proportional to its quality. The experts also gave higher rating 4.87 on how the workstation may be assembled and reproduced; however, students' rating is a bit lower 4.7 but still *very acceptable.* As regards the appropriateness of the materials used, both the experts' 4.93 and the students 4.7 gave a *very acceptable rating*. The overall rating of the workstation in terms of the cost-effectiveness is 4.77 which is interpreted as *very acceptable.*

Safety is one of the major indicators for the acceptability of the workstation. The overall rating of evaluators is 4.83 which interpreted as *very acceptable.* The students rated the Emergency Stop Button with 4.9; while the experts' rating is 4.87, both interpreted as *very acceptable.* The Antistatic Materials under safety is dealing with static charges that can damage the electronic components once not properly handled. The workstation has anti-static materials to avoid unwanted damage to the components thus the experts rated it 4.87; the students, 4.6. The circuit breaker is essential for electrical wiring and safety that is why it was included in the workstation. As regards the accessories and the labels built in the workstation, the experts and students rated it with 4.85 and 4.93, respectively.

The project was designed to be mobile. The evaluation result is *very acceptable* with the rating of 4.93 by the experts, and 4.85 by the students. The heavy-duty roller wheels of the workstation is the reason why both groups of evaluators rated the project with high acceptability level. As regards the stability and quality of works, the experts gave it a rating of 4.6, and the student, 4.7 interpreted as very acceptable. The installation of equipment and instruments was rated 4.87 by the experts, and 4.80 by the students. It was shown that the equipment and instruments are properly installed on the wooden cabinet. As to the accessibility for maintenance and replacement, both groups of evaluators gave a rating of 4.80 or very acceptable since all the components used in the project are locally available in the market. To summarize, the rating of the experts and students in terms of workmanship are 4.8 and 4.7, respectively.

Table 1 below shows the summary of the evaluation of the acceptability of workstation by the experts and the students in terms of functionality, cost-effectiveness, safety, and workmanship.

Table 1. Acceptability of the Mobile Workstation

Item	Weighted Mean		Total WM	VI
	Experts	Students		
Functionality	4.83	4.74	4.78	VA
Cost-Effectiveness	4.80	4.73	4.77	VA
Safety	4.88	4.77	4.83	VA
Workmanship	4.88	4.75	4.78	VA
Over-all WM	4.85	4.75	4.79	VA

WM: Weighted Mean; VI: Verbal Interpretation;
VA: Very Acceptable

IV. CONCLUSIONS AND RECOMMENDATIONS

Based on the findings of the study, it is concluded that the Mobile Workstation for Electronic Products Assembly and Servicing NC II is very acceptable in terms of functionality, cost-effectiveness, safety, and workmanship as perceived by the trainers, experts, and students in EPAS NC II.

Based on the result of the evaluation, it is recommended that this workstation be used in the classroom as an instructional material specifically for developing competencies in EPAS NC II. Since it is low cost as this can be reproduced schools that offer EPAS NC II program. The method in developing the workstation can serve as a guide for other trainers and researchers in creating their workstations and instructional materials.

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