

# Enhancing Solar Panel Light Tracker as Instructional Material among Technology Students

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## Abstract

Teachers employ a variety of methodologies and teaching strategies in order to deliver quality instruction and acquisition of new skills. Thus, instructional materials is deemed necessary to aid the instructors in the teaching-learning process. This study aimed to evaluate and validate the teacher-made instructional material for technology students. Descriptive statistics was employed particularly mean and standard deviation in order to analyze the data with regards to validity of the solar panel light tracker. It is evaluated by 20 Electrical and Electronics Technology students and 15 Instructors. The t-test for Independent data was used to test the significant difference between scores of the two groups of respondents. All statistical inferences were based on the five percent (5%) level of significance. The teacher-made Instructional material was found very good in terms of the design, construction, functionality and efficiency, safety and durability. The teacher made instructional material instructional (solar panel light tracker) is found valid as Instructional material by the students and instructors. Thus, its utilization is recommended to improve the teaching learning process.

**Keywords:** Instructional Material, Technology, Teacher-made

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## 1. INTRODUCTION

In the field of instruction, demands for new approaches, strategies and techniques become a buzzword. The modern classroom has been envisioned to respond to these demands by emphasizing the development of basic skills-

technical and work skills that would enhance learning capabilities and improve quality and outcome based education. This holds true even to instruction in Electrical and Electronic Technology.

As emphasized by Ramos [1](2008) technological researches help create products and materials that are ready for operational use in the classroom and in the society. Through technological researches, innovations in education can be possibly done. Thus, educational research and development increases the potential impact of translating research results into usable products that may improve the educational process and eventually level up the living conditions of the Filipinos. Since technology brings change to our society, innovating gadgets like the solar panels light tracker is a great move. It is hoped that the gadget as an offshoot of the study is an effective way in gathering energy and thus to save energy and cost.

The fact that instructional materials (IM) has been proven to produce more effective and efficient learning as claimed by Laron (1994) cited by Rion (2014) there is still inadequacy in the number of instructional resources as well as the number of tools and equipment in the number of students enrolled based from the findings of Albarico et al. (2014)

It is in this light that the researchers considered developing and evaluating multi-purpose solar panel light tracker at Isabela State University as an IM's in teaching Electrical Technology subjects. This gadget as learning tool is aptly dubbed as multi-purpose solar panel light tracker. This gadget was designed as instructional material as well as a power supply device. Its function is

further focused on enhancing the competency of students in Electrical and Electronics Technology.

It is the main purpose of the study is to evaluate and validate the Solar Panel Light Tracker as Instructional material. Specifically, this study was conducted to determine the following:

1. How valid is the solar panel light tracker in terms of: design and structure, construction, functionality/efficiency, safety and durability.
2. Determine significant difference between the evaluations of the two groups of respondents on the solar panel light tracker in terms of its components.
3. How effective is the solar panel light tracker in teaching Electrical Technology 61 and 62 subjects?

## 2. METHODOLOGY

Descriptive statistics was employed particularly mean and standard deviation in order to analyze the data with regards to validity of the solar panel light tracker. It is evaluated by 20 Electrical and Electronics Technology students and 15 Instructors. The t-test for Independent data was used to test the significant difference between scores of the two groups of respondents. All statistical inferences were based on the five percent (5%) level of significance.

### Distribution of Faculty and Student Respondents per Campus

Campus	Population		Respondents		Percentage	
	Student	Faculty	Student	Faculty	Student	Faculty
Angadanan	15	10	5	5	25%	33.33%
Cauayan	15	10	5	4	25%	26.67%
Iligan	15	10	5	3	25%	20.00%
San Mateo	15	5	5	3	25%	20.00%
Total	60	35	20	15	100%	100%

## RESULTS AND DISCUSSION

### Validation of the Solar Panel Light Tracker

**Table 2. Summary of Evaluation of Technology Instructors of the Developed Solar Panel Light Tracker in Terms of Design**

Item	Statements	Mean	Item Qualitative Description
1	The design is suited to instructors, tertiary students and consumers.	1.31	Strongly Agree
2	Parts/supplies/materials of the trainer are available in electrical and electronic hardware/stores.	1.56	Strongly Agree
3	The component parts are strategically located.	1.44	Strongly Agree
4	The component parts are visible.	1.19	Strongly Agree
5	The component parts are replaceable.	1.25	Strongly Agree
	Grand Mean/Interpretative Description	1.35	Very Good

This finding means that the respondents consider the trainer as acceptable in terms of its design. This could imply that the researcher carefully planned the design of the trainer such that it could really serve the purpose for which it is developed and constructed. The findings affirm the study of Ruma (2014). The results also show that the respondents were consistent in their evaluation which implies that the researcher applied the proper procedures and techniques through specific process like determining the functions of the machine, its performance and acceptability.

**Table 3. Summary of Evaluation of Technology Students of the Developed Multi-Purpose Solar Panel Light Tracker in Terms of Design**

Item	Statements	Mean	Item Qualitative Description
1	The design is suited to instructors, tertiary students and consumers.	1.19	Strongly Agree
2	Parts/supplies/materials of the trainer are available in electrical and electronic hardware/stores.	1.33	Strongly Agree
3	The component parts are strategically located.	1.33	Strongly Agree
4	The component parts are visible.	1.24	Strongly Agree
5	The component parts are replaceable.	1.29	Strongly Agree
	Grand Mean/Interpretative Description	1.28	Very Good

As a whole, data show that the student respondents evaluated the developed multi-purpose solar panel light tracker in terms of its design to be excellent as evidenced by the grand mean of 1.28.

This means that the respondents consider the trainer as acceptable in terms of its design. This also implies that careful planning was observed in designing the trainer such that it could really serve the objectives of its development and construction.

This finding is supportive of the assertion of Seguban (2012), Cabardo (2003), Aldara (2011) and Bungag (2003).

**Table 4. Summary of Evaluation of Technology Instructors of the Developed Multi-Purpose Solar Panel Light Tracker in Terms of Construction**

Item	Statements	Mean	Item Qualitative Description
1	The set-up is well-organized.	1.31	Strongly Agree
2	The attachments of the component parts well and neatly arranged.	1.50	Strongly Agree
3	All attachments are purposeful and functional.	1.44	Strongly Agree
4	The panel senses the ray of the sun.	1.31	Strongly Agree
5	The frame of the solar panel and other parts of the devices are built properly.	1.63	Strongly Agree
	Grand Mean/Interpretative Description	1.44	Very Good

It could be noted in the table that again the instructor respondents are one in saying that the developed panel light tracker was constructed very well as evidenced by the overall mean rating of 1.44. This means that the set up well-organized, the attachments of the component parts are well and neatly arranged, all the attachments are purposeful and functional, the panel senses the ray of the sun, and the frame of the solar panel and other parts of the devices are built properly.

**Table 5. Summary of Evaluation of Technology Students of the Developed Multi-Purpose Solar Panel Light Tracker in Terms of Construction**

Item	Statements	Mean	Item Qualitative Description
1	The set-up is well-organized.	1.33	Strongly Agree
2	The attachments of the component parts well and neatly arranged.	1.24	Strongly Agree
3	All attachments are purposeful and functional.	1.19	Strongly Agree
4	The panel senses the ray of the sun.	1.33	Strongly Agree
5	The frame of the solar panel and other parts of the devices are built properly.	1.24	Strongly Agree
	Grand Mean/Interpretative Description	1.27	Very Good

It could be seen in the table that just like the technology instructors, they strongly agreed that the developed multi-purpose solar panel light tracker trainer is very well constructed as evidenced by the overall mean rating of 1.27.

**Table 6. Summary of Evaluation of Technology Instructors of the Developed Multi-Purpose Solar Panel Light Tracker in Terms of Functionality and Efficiency**

Item	Statements	Mean	Item Qualitative Description
1	It is effective for conserving energy and instructional use.	1.31	Strongly Agree
2	It acts as charging device.	1.19	Strongly Agree
3	It can perform as an		

	alternative source to a low voltage electronic gadget.	1.19	Strongly Agree
4	It is easy to operate/manipulate.	1.38	Strongly Agree
5	It can perform simple to complex activities like charging the batteries while harvesting/gathering energy from the sun.	1.38	Strongly Agree
	Grand Mean/Interpretative Description	1.29	Very Good

This means that the set up well-organized, the attachments of the component parts are well and neatly arranged, all the attachments are purposeful and functional, the panel senses the ray of the sun, and the frame of the solar panel and other parts of the devices are built properly, which imply that it could be easily transported for instructional purposes.

**Table 7. Summary of Evaluation of Technology Students of the Developed Multi-Purpose Solar Panel Light Tracker in Terms of Functionality and Efficiency**

Item	Statements	Mean	Item Qualitative Description
1	It is effective for conserving energy and instructional use.	1.05	Strongly Agree
2	It acts as charging device.	1.19	Strongly Agree
3	It can perform as an alternative source to a low voltage electronic gadget.	1.29	Strongly Agree
4	It is easy to	1.24	Strongly

	operate/manipulate.		Agree
5	It can perform simple to complex activities like charging the batteries while harvesting/gathering energy from the sun.	1.10	Strongly Agree
	Grand Mean/Interpretative Description	1.17	Excellent

The registered overall mean rating of 1.17 described as “Excellent” which indicates that the respondents rated excellent that the improvised or developed trainer is a functional instructional material, which performs different laboratory activities related to electrical technology.

The study of Dena-em (2006) as cited by Ruma (2014) is supportive of the findings of the present study that projects can be effective mock-ups and trainers, particularly when they are capable of simultaneous multi-task operations. These machines help instructors and students in their hands-on activities, particularly in laboratory activities.

**Table 8. Summary of Evaluation of Technology Instructors of the Developed Multi-Purpose Solar Panel Light Tracker Trainer in Terms of Safety**

Item	Statements	Mean	Item Qualitative Description
1	The stand/frame/base is safe to use.	1.56	Strongly Agree
2	The component parts are designed for low voltage source.	1.19	Strongly Agree
3	The mock-up is equipped with a safety warning	1.69	Strongly Agree



	devices		
4	The installation of the circuits makes the device safe for demonstration.	1.25	Strongly Agree
5	It is guided by procedure for an operation.	1.63	Strongly Agree
	Grand Mean/Interpretative Description	1.46	Very Good

This finding means that the trainer is very safe to use and can be used effectively by anybody following the procedures as well as the safety precautions in the manual of operations. It could also mean that the trainer/mock-up is equipped with safety devices and installation of the circuit is safe for demonstration since the connecting wires or leads conform to standards.

This could be attributed to the fact that the researcher adhered to the necessary safety standards in designing and constructing the said trainer. According to Palabay (2006), one of the principles of invention that should be given due consideration is the inclusion of safety standards. He further stressed that safety precautions should be written in simple language to facilitate understanding.

**Table 9. Summary of Evaluation of Technology Students of the Developed Multi-Purpose Solar Panel Light Tracker in Terms of Safety.**

Item	Statements	Mean	Item Qualitative Description
1	The stand/frame/base is safe to use.	1.29	Strongly Agree
2	The component parts are designed for low voltage source.	1.38	Strongly Agree
3	The mock-up is	1.29	Strongly

	equipped with a safety warning devices		Agree
4	The installation of the circuits makes the device safe for demonstration.	1.14	Strongly Agree
5	It is guided by procedure for an operation.	1.19	Strongly Agree
	Grand Mean/Interpretative Description	1.26	Very Good

This finding manifested that even the students strongly agreed that the trainer is equipped with safety devices that would prevent accidents to happen while they actually perform the different task in the automotive laboratory. This is supported by Yangco (2008) in Ruma (2014) who recommended that machines should have safety devices to prevent accidents from occurring while being used. It is important according to him that non-adherence to the user's manual may endanger the safety or even the life of the user.

It is now the duty of the technology teachers to help solve the problem on the inadequacy of equipment, tools and instructional materials by continuously inventing and discovering new instructional materials that could enhance learning and eventually improve performance.

**Table 10. Summary of Evaluation of Technology Instructors of the Developed Multi-Purpose Solar Panel Light Tracker in Terms of Durability**

Item	Statements	Mean	Item Qualitative Description
1	The parts of the device are protected from any theft or unnecessary materials.	1.31	Strongly Agree

2	It can stand with the weather condition.	1.69	Strongly Agree
3	It can operate/work within less than 10 years.	1.63	Strongly Agree
4	It works at night time condition	1.63	Strongly Agree
5	The solar panel is fragile/breakable.	1.31	Strongly Agree
	Grand Mean/Interpretative Description	1.51	Very Good

The parts of the device are protected from any theft or unnecessary materials, it can stand with the weather condition, it can operate/work within less than 10 years, it works at night time condition, and the solar panel is fragile/breakable.

This finding could mean that the device is made of durable supplies and materials and is designed in such a way that it can withstand any inclement weather condition.

Table 11. Summary of Evaluation of Technology Students of the Developed Multi-Purpose Solar Panel Light Tracker in Terms of Durability

Item	Statements	Mean	Item Qualitative Description
1	The parts of the device are protected from any theft or unnecessary materials.	1.19	Strongly Agree
2	It can stand with the weather condition.	1.33	Strongly Agree
3	It can operate/work within less than 10 years.	1.48	Strongly Agree

4	It works at night time condition	1.14	Strongly Agree
5	The solar panel is fragile/breakable.	1.14	Strongly Agree
	Grand Mean/Interpretative Description	1.26	Very Good

This finding indicates that proper planning and designing were undertaken by the researcher with the inclusion of a tracker sensing device with a stepper motor to automatically follow the direction of the sun, so that it can capture sunlight any time of the day effectively.

Table 12. Summary of t-test on the Mean Differences in the Evaluation of the Two Groups of Respondents on the Developed Multi-Purpose Solar Panel Light Tracker in Terms of Design

Respondents	Mean	Mean Difference	Computed t-value	p-value	Remarks
Instructors	1.35	0.07	0.7097	0.4826	Not Significant
Students	1.28				

The mean difference when tested yielded a t-value of 0.7097 with a p-value of 0.4826 which higher than 0.05 level of significance. Therefore, there is no significant difference in the evaluation of the two groups of respondents on the developed multi-purpose solar panel light tracker in terms of its design.

This finding means that irrespective of who evaluates the trainer in terms of its design, no significant difference was noted. It means that the trainer was designed properly following standards and that all factors were considered to suit to the needs of future users and that all parts were properly situated and locally available in any automotive parts stores.

**Table 13. Summary of t-test on the Mean Differences in the Evaluation of the Two Groups of Respondents on the Developed Multi-Purpose Solar Panel Light Tracker in Terms of Construction**

Respondents	Mean	Mean Difference	Computed t-value	p-value	Remarks
Instructors	1.44	0.17	1.651	0.1077	Not Significant
Students	1.27				

With respect to the t-test result on the mean difference of 0.17 in the evaluation of the two groups, it registered a t-value of 1.651 with p-value 0.1077, which is higher than 0.05 level of significance. This means that there is no significant difference in the evaluation of the two groups of respondents on the developed basic automotive engine electrical systems trainer in terms of its construction.

This could be interpreted to mean that instructors and students alike may register almost equal evaluation of a constructed trainer or mock-up. Further, it could mean that the trainer/mock-up was constructed applying the correct procedures and principles in constructing such trainer. It could also give the impression that the components of the trainer are well-organized, properly built, neatly arranged, purposeful and functional. It is also portable allowing it to be transported anywhere for instructional purposes.

This finding is supported by Palabay (2010) who agreed that objectives of design and procedures in constructing a machine are factors to be considered in determining its functionality, durability and safety.

It is now at this point that technology instructors should endeavor in constructing instructional materials that could enhance performance of students in the technology subjects. As pointed out by Prosser and Quigley (1997), inventions and

discovery are continually creating new instructional devices and in turn, technological institutions should adopt necessary strategies for the development and efficient use of these developed materials to make the teaching-learning process effective.

**Table 14. Summary of t-test on the Mean Differences in the Evaluation of the Two Groups of Respondents on the Developed Multi-Purpose Solar Panel Light Tracker in Terms of Functionality and Efficiency**

Respondents	Mean	Mean Difference	Computed t-value	p-value	Remarks
Instructors	1.29	0.12	1.428	0.1622	Not Significant
Students	1.17				

The mean difference of 0.12 was tested using independent t-test, it yielded a t-value of 1.428 with p-value 0.1622 which is higher than 0.05 level of significance. Therefore, there is no significant difference in the evaluation of the two groups of respondents on the evaluation of the two groups of respondents on the developed basic automotive engine electrical systems trainer in terms of its functionality and efficiency.

This could mean that both groups had almost the same evaluation of the functionality and efficiency of the solar panel with tracker. This could mean that the panel is found to be functional and efficient instructional material; can perform several activities/operations from simple to complex; and it is easy to operate or manipulate.

This finding aptly supports the finding of Bangayan and Cristobal (2005) who concluded that the instructional model developed in their study is an effective instrument for the enhancement of the teaching-learning process. Dale (1985) in Ruma (2014) stressed that to be properly used, instructional materials should become a part of a planned teaching-learning



system in which the teacher continues to play a leading role in the selection, use and evaluation of different teaching aids. According to him, this will free the teacher from repetitive tasks so that he can work toward the attainment of the ultimate goal of education to enhance academic performance of students.

**Table 15. Summary of t-test on the Mean Differences in the Evaluation of the Two Groups of Respondents on the Developed Multi-Purpose Solar Panel Light Tracker in Terms of Safety**

Respondents	Mean	Mean Difference	Computed t-value	P-value	Remarks
Instructors	1.46	0.21	1.891	0.0669	Not Significant
Students	1.25				

The mean difference of 0.21 when tested using independent t-test yielded a t-value of 0.7000 with p-value 0.486 which is higher than 0.05 level of significance. Therefore, there is no significant difference in the evaluation of the two groups of respondents on the evaluation of the two groups of respondents on the developed basic automotive engine electrical systems trainer in terms of its safety.

This could be interpreted that regardless of the group of evaluators, both groups see that the solar panel with tracker is safe for use by instructors and students. That the components parts of the solar panel are designed for low voltage source and it is equipped with safety devices. The size of connecting wires/leads conforms to standards and it could be safely used for demonstration purposes since it contains procedure for operation.

**Table 16. Summary of t-test on the Mean Differences in the Evaluation of the Two Groups of Respondents on the Developed Multi-Purpose Solar Panel Light Tracker in Terms of Durability**

3	Mean	Mean Difference	Computed t-value	P-value	Remarks
Instructors	1.51	0.25	2.231	0.0263	Significant
Students	1.26				

The t-test analysis of the mean difference of 0.25 yielded a t-value of 2.321 with a p-value of 0.0263, which is lower than 0.05 level of significance. This means that there is a significant difference in the evaluation of the two groups of respondents on the durability of the developed solar panel light tracker.

The significant difference noted could be attributed to the fact that the two groups had different views on the life span or durability of the developed panel.

## EFFECTIVENESS OF THE SOLAR PANEL LIGHT TRACKER AS IM

**Table 17. Distribution of the pretest and posttest scores of the students**

Score Scale	Pre-test		Post-test	
	Frequency	Percentage	Frequency	Percentage
41-50			2	10.00
31-40			8	40.00
21-30	5	25.00	9	45.00
11-20	14	70.00	1	5.00
1-10	1	5.00		
Total	20	100	20	100

Table 17 shows the result of the pre-test and post-test scores of the students. It can be gleaned from the table that there is a significant increase in the achievement of the students after the utilization of

the Solar Panel Light Tracker in teaching. In the pre-test scores scale 11-20 has the highest frequency, followed by 21-30 score scale, and last 1-10 score scale. Moreover, in the posttest nobody got a score of 20 and below. This means that scores using the Solar Panel Light Tracker in teaching ET 61 (PLC System and Programming) and ET 63 (Automation Control System) as an intervention in the teaching-learning process it improves the scores of the students.

**Table 18. The t-test of difference between pre-test and post-test mean scores of the students.**

	ET Test	
	Pre-test	Post-test
Mean	17.75	30.45
Standard Deviation	4.94043	5.94249
Mean Difference	19	
t-value	0.000*	
(two-tailed)		

N= 20

\*p < 0.05

The significance of the difference in the mean of pre-test and post-test scores of the students was tested using the t-test. It appears that a significant increase occurred in the ET test as a result of the implementation of the Solar Panel Light Tracker as an IM in the teaching-learning process. The computed t-value (0.000) indicates that there is a significant difference between the mean of the pre-test and the mean of the post-test score of the students at 0.05 level of significance of a two-tailed test. This result implies that the Solar Panel Light Tracker IM is capable of improving the students' performance in ET 61 and ET 63. It also shows that it is effective tools in learning Electrical and Electronic Technology subjects.

## Conclusion

1. The teacher-made Instructional material was found very good in terms the design, construction, functionality and efficiency, safety and durability
2. The teacher made instructional material instructional (solar panel light tracker) is found

valid as Instructional material by the students and instructors.

3. It is an effective tool in learning Electrical and Electronics Technology subjects.

## Recommendation

1. Further studies on the effect of teacher-made instructional material on student's performance.
2. To further establish the acceptability of the trainer, an experimental study be conducted to determine its effectiveness in enhancing the psychomotor performance of students.
3. Administration could allocate more funds for the development and validation of improvised trainers, gadgets, multi-purpose machines to improve students' performance in the technology courses

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