Learning Electronics through Problem-Solving Activities as an Ethnomethodology Experience among College Students

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Abstract

This qualitative research study explicated and discussed how Problem-solving (PBS) activities and instructional materials made Physics visible and learnable. Evidences on the learning of Electronics through PBS activities were illustrated including witnessable orientation towards the practical achievement of understanding among Fourth Year college Physics students at a Teacher Education Institution in Iloilo City, Philippines. This research study examined the ethnomethodological experiences of students in different claims and how these claims built their interpretation as well as understanding on Electronics through PBS activities. The data in this research were gathered through PBS activity sheets, participant's journal, Focus Group Discussion (FGD), video clips, and findings from individual semi-structured interview. The data gathered were analyzed through Conversational Analysis (CA) with summary of findings illustrated. The study revealed that the claims of students' understanding on Electronics through PBS activities were classified under the constructs of 'acceptance, affirmation, assertion, assurance, effective communication, familiarity, guessing, insistence, profess, and prior knowledge'. Results also showed the following displays of students' understanding being classified as: 'assay of the students, students' undertakings, and students' realizations''. The researcher further found that these claims and displays helped building students' interpretation that form their understanding on Electronics through PBS activities. Finally, when the students attempted to solve the problem, the issue of the practical achievement of understanding was relatively clear to them, for example, they needed to understand the problem regarding movements to be able to solve it adequately. When taken together, the claims and displays of students achieved an understanding of how materials, task structure, and teacher interventions worked to make both mechanics as well as student's understanding visible, accessible, and manifestable.

Keywords: Constructivism; Conversational analysis; Electronics; Ethnomethodology; Grounded theory; Problem-solving (PBS) activities

Introduction

Background, Rationale and Problem Statement

In lieu of Commission on Higher Education (CHED) Memorandum Order No. 30 series of 2004, Article II Section 6, stated that "Graduates of the BEEd and BSEd programs are teachers who have the basic and higher literacy, communication, numeracy, critical thinking, learning skills needed for higher learning" (CHED Memo #30, s. 2004). College graduates also need to be self-directed, critical thinkers, problem solvers, analytical in their approach and possess lifelong learning skills. The nature of work is to be able to integrate knowledge and skills from a number of disciplines as well as the interpersonal and intrapersonal skills to be an effective member of a group activity.

Literature revealed that learner-centered approach incorporating problem-solving (PBS) activities aimed at promoting student's thinking skills with capability to solve problems requiring especially pedagogical content knowledge related to Science and Mathematics. Students work together in small groups to analyze a problem and gather insights in each member of the group to find a solution colleaboratively. In this educational setting, teachers act as a facilitator instead of giving discussions to students. Students take charge of their own learning experience against having it handed to them.

The concept of 'visibly-rational-and-reportable-for-all-practical-purposes' (Garfinkel, 1967) in which this study is anchored on is an investigation of rational properties of indexical expressions and other practical actions as ongoing contingent accomplishments of organized practices of everyday life. With this in mind, this paper intended to explicate and discuss in some ways in which PBS and student's understanding of PBS activities become visibly-rational-and-reportable-for-all-practical-purposes. The concept is taken from *ethnomethodology*, which provides the methodological and analytical approach of this study when used in science education.

In addition, the review of literature revealed that quality learning is done through quality teaching incorporating student-centered learning involving PBS activities that can be integrated in students' science learning and interpreted through symbolic interactionism (as elaborated in subsequent section) in order to enhance the teaching-learning process in Physics, as guided by the principle that education is a lifelong activity and does not cease after one's graduation in school. The researcher also wanted to know how students understood the concept being solved through PBS activities in Electronics as well as whether it enhanced the teaching-learning process in science education, especially in the field of Physics.

Purpose of the Study and Research Questions

This study aims at explicating how Problem-solving (PBS) activities and instructional materials made Physics visible and learnable with illustrations on learning evidences as well as practical achievement in understanding Electronics among Fourth Year college Physics students at a Teacher Education Institution in Iloilo City, Philippines.

The findings of this paper may be of great relevance to the college Physics educators to integrate the pedagogical method of PBS activities in Electronics as their tool in facilitating students' learning with development of critical thinking skills. The paper may also serve as a feedback to Curriculum planners, policy makers, subject coordinators, supervisors, and administrators in science that they may develop plans or new curricula to enhance science competence and teaching performance of teachers for students to benefit.

This study was guided by the following two research questions:

1. What are the different claims and displays of students' understanding through PBS activities in Electronics?
2. How do these claims and displays help build students' interpretation and understanding of the PBS activities in Electronics?

Review of Related Literature and Methodological Issues

This paper is qualitative in nature, which is situated in the epistemology of constructivism that 'meanings are constructed by human beings as they engage with the world they are interpreting' (Crotty, 2003). Symbolic interactionism is the theoretical perspective that informs the methodology and provides a context for the process.

The theoretical framework based on the Epistemology of Constructionism (another term of Constructivism) believes that there is no objective truth. There is no single reality. Meanings are not discovered but constructed. Reality is constructed in groups not individually. Symbolic interactionism provided the theoretical lens for ascertaining and interpreting teachers' and students' symbolic representations of their content knowledge during instruction. In many cases, the participants attempted to provide explanations of difficult concepts by establishing symbolic relationships that will be relevant and meaningful to the student. Subsequently, classroom interactions produced modifications in these symbolic representations, thereby enhancing student understanding.

Symbols are social because they are developed and refined through social interaction, and they are significant because they convey pertinent meanings to both the user of the symbol and the recipient during communication. The person who uses symbols does so for the purpose of giving off meaning that he or she believes will make sense to the other (Charon, 1992).

Table 1
Epistemological and Theoretical Framework

Epistemology	Theoretical Perspective	Micro-Theories
● Constructionism (Crotty, 2003)	● Symbolic Interactionism (Blumer, 1969; Esterberg, 2002)	● Ethnomethodological Approach (Garfinkel, 1967)

Constructionism Paradigm

Constructionism is another term of constructivism. The constructivist view of learning has made a major impact on science education, particularly during the past decade (Treagust, 1996). The implications for a science curriculum centered on a constructivist philosophy were identified initially in a number of research studies which focused on students' concept learning in science (Driver & Oldham, 1986). The constructivist view of learning has had the most noticeable influence on curriculum thinking in science since 1980 (Wubbels & Brekelmans, 1997). From an educational standpoint, students construct knowledge as they attempt to make sense of what is being taught by trying to fit it in with what they already knew. Glasersfeld (2005) proposed a radical form of constructivism, which advances the notion that knowledge is not a kind of product that exists apart from the knower but an activity or process that has purpose and direction. The validity of a knowledge claim is not to be found in the relationship of reference or correspondence to an independently existing world; rather, a claim is thought to be valid if it is viable or if it provides functional fit, that is, if it works to achieve a goal (Denzin & Lincoln, 1994).

Symbolic Interactionism

The fundamental theoretical perspective for this study is the interpretivist approach of symbolic interactionism. Historically, interpretivism developed as a means of extricating social science research from the grasp of natural science methodologies. Wilhelm Dilthey (1976) speculated that the reality of natural science and the reality of social science are completely different entities and, therefore, demand radically different research methodologies. It is in this light that the researcher sought to assess the learning of Electronics through PBS activities as an ethnomethodology experience among college Physics students in a Teacher Education Institution for the school year 2015-2016. To produce a quality product, one must be molded from PBS activities and made out of a quality material.

Ethnomethodology

This research method is concerned with the specification of the methods used by people by means of which the structures of the world they inhabit come to be produced and recognized. In the specification of its methods with descriptions more or less clearly and comprehensively, the formal analysis reveals the evidences that its methods are different. But ethnomethodology points out that underlying these different methods remain the competent methods of the people, which are a required competence on the part of analysts to have any chance of perceiving and understanding what people are doing (Roth, 2009).

Many areas in science education have achieved corpus status, including, for example, a corpus on students' and teachers' views of the nature of science, another one on these members' beliefs, and yet another corpus on conceptions and conceptual change. The corpus status of these literatures is undeniable, well known, and pointless to dispute (Roth, 2009). In the same way as ethnomethodology, science education can only gain when it follows ethnomethodology and focuses on '''What more' is there that users of formal analysis know and demand the existence of, that [formal analysis] depends upon the existence of for [formal analysis]'s worksite-specific achievements in carefully instructed procedures, that [formal analysis] uses and recognizes everywhere in and as its lived worksite-specific practices'' (Garfinkel, 1996).

Research Design

The design of this paper was constructed based on the researcher's epistemological assumptions and purpose of this study concerning how members of the group made sense on the given PBS activities as well as how they analyzed, understood, and accomplished learning tasks. This paper is ethnomethodological in nature in which one is able to share with their peers about their experiences that lead to knowledge construction, the identity of the knower is created and a deeper understanding is discovered. Video and audio recorders were used in order to show through careful and detailed account of actual or in a natural interaction setting of the participants as they solved problems in the activities.

The researchers served as the instructors for four weeks in the course entitled Electronics for the second semester. The participants were twelve fourth year college Physics and three Physical Science students of a Teacher Education Institution in Iloilo City, Philippines. They were grouped into three and each group had five members.

The researchers started by asking permission from the proper authorities and inform the participants about the overview of this study. Consent form was distributed for the video recording, Focus Group Discussion (FGD), and in-depth interview. This was to inform the participants of their schedule of the lectures, video recording, PBS activities (refer to Appendix A), FGD, and interview. The researchers prepared the exemplary lesson plans (refer to Appendix B) and PBS activities with instructional materials. The paper is limited only on the following specific topics; Electric Current, Optoelectric Devices, Electrical Measurements, and Power Supplies. These were taken from the course syllabus of the professor-in-charge. Four weeks were the duration of the study. Twice a week was the meeting session of the researchers and participants. The participants took down notes in their personal journal notebook on what they had learned from the lectures and the PBS activities as their reflections. The researchers also prepared discussions and explanations after the PBS activities were done. The participants were grouped into three, each group with 5 members. During the lesson sessions and activities, a video recording was done. After the lesson sessions and PBS activities, the participating groups were able to watch the video recording during the PBS activities for five minutes and each group had a Focus Group Discussion (FGD) with the researchers and their personal journals were collected and analyzed. The researchers returned the journals in the following week. The researchers asked each group a representative or a volunteer to have an in-depth interview for more reliable data. After the FGD, the in-depth interview was done.

The audio recorded data were analyzed through transcription which is a written form that was amenable to conversational analysis (talk-in-interaction analysis). In analyzing the transcripts, the first step is identifying the words or phrases that was given emphasis to extract the units of relevant meaning. In other words, it is called Delineating units of meaning relevant to the research questions. Two types of analysis that were used in this study included the Conversation Analysis and Thematic Analysis of Grounded Theory (Glaser & Strauss, 1967). The data sought to explicate and discuss the different claims and displays of students' understanding through PBS activities and how these claims and displays build students' interpretation and understanding in Electronics. From the ethnomethodological experiences of students' claims and understanding were formed and narrated. These stories were formed through coding, identifying major categories and themes with their respective discussion and explanations which were guided by the epistemological assumptions, research purpose, and research questions. The entire process for the collection and analysis of data is presented in the following Figure 1.

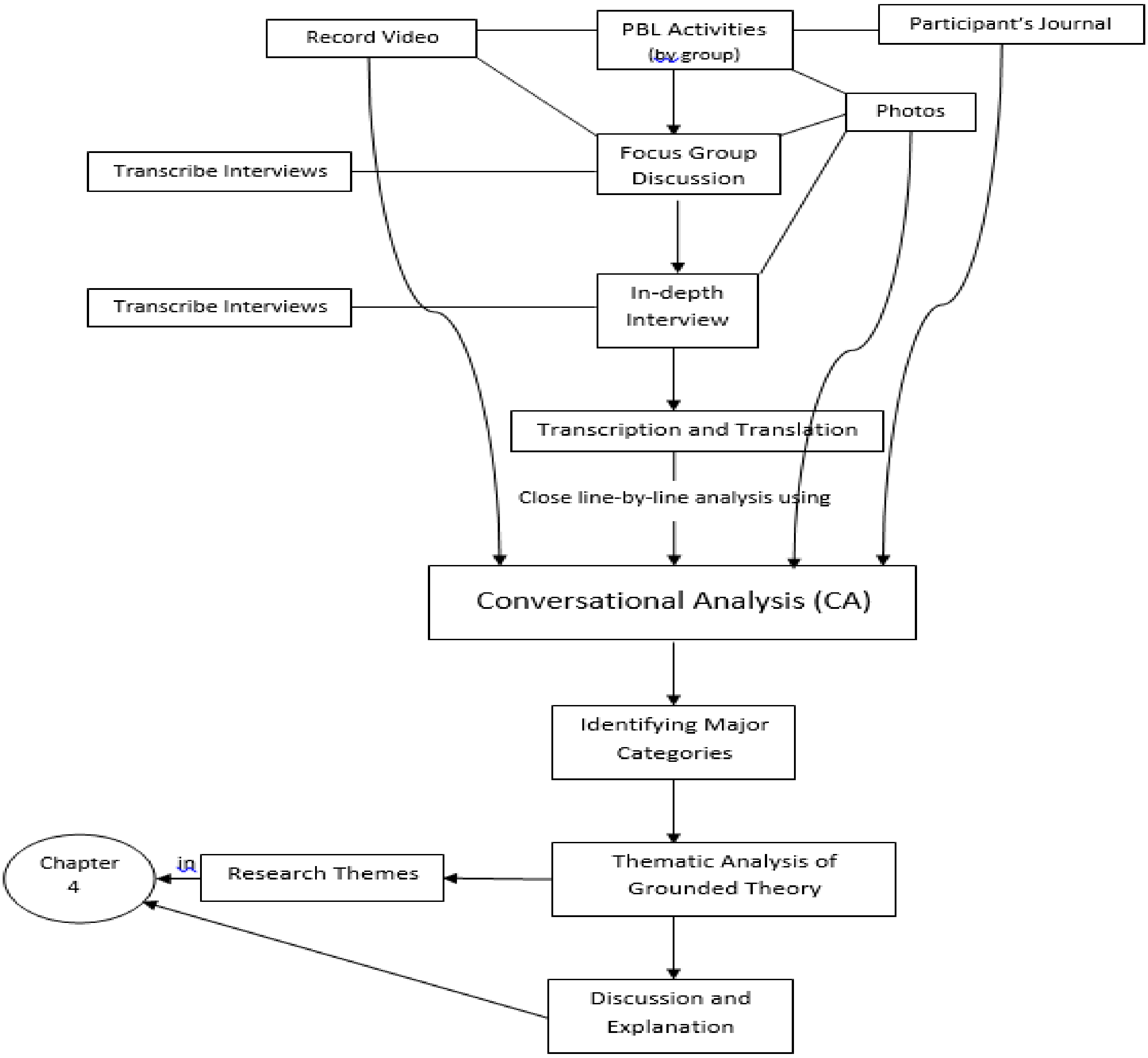

Figure 1. Schematic diagram for the entire process of the collection and analysis of data.

Results

The researchers undertook various ways to come up with the major themes of the study. In a collaborative activity such as PBS, learners were involved in constructing consensual meanings, interpretations, and practical understandings.

Claims of Students Understanding

With the starting point in the findings using Conversation Analysis and Thematic Analysis of Grounded Theory, the discussion began with the distinction between claims of students' understanding of PBS activities. These are the following: acceptance, affirmation, assertion, assurance, effective communication, familiarity, guessing, insistence, professing, and prior knowledge (Figure 2).

In ordinary interaction, it is often enough for all practical purposes to provide a minimal response, such as an 'hmm' or 'yeah' which implies that one has understood what their peers has said. It was also found out that the claims of students' understanding which was shared by the students with their group mates during the PBS activities on the clusters implying the ten claims shared by the students including 'acceptance, affirmation, assertion, assurance, effective communication, familiarity, guessing, insistence, professing, prior knowledge, and assertion' were among the claims mostly shared.

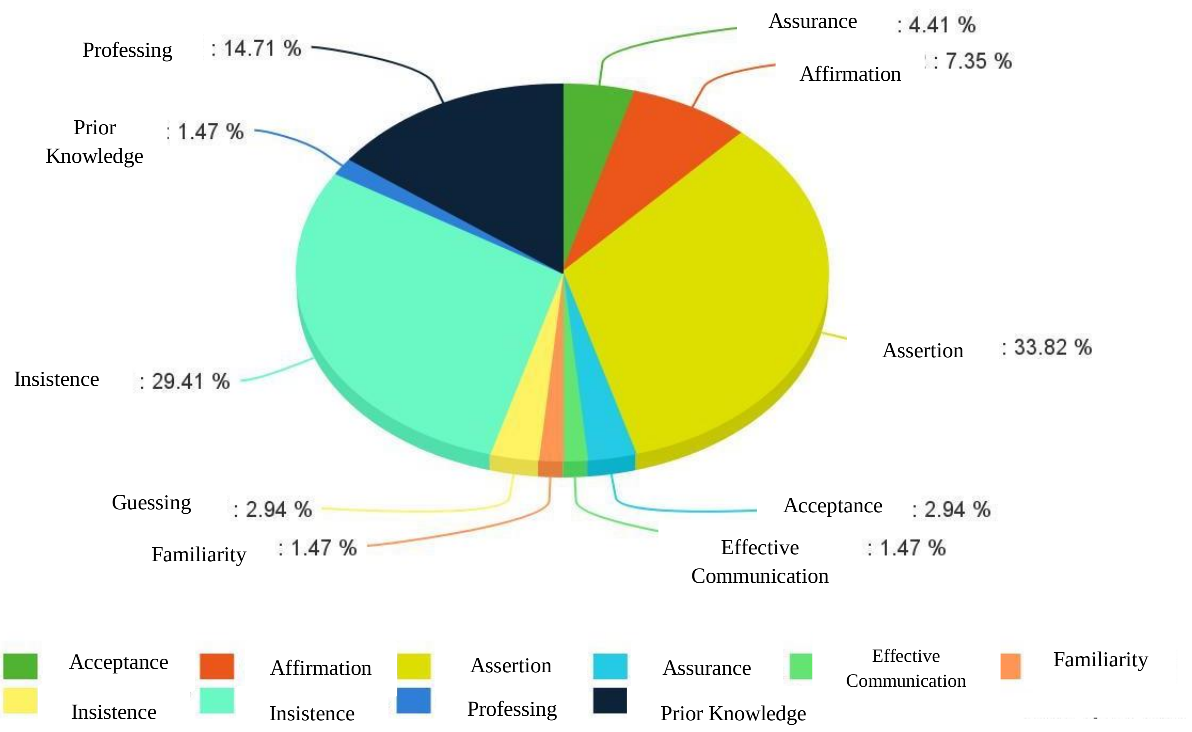

Figure 2. Claims of students' understanding shared with the group.

Acceptance. It can be seen from the results of the transcripts that acceptance come to play in the learning process specifically in the dynamics of the PBS activity. Transcripts from the observations exemplified students' acceptance of ideas/opinions/suggestions on what to do related to the learning task at hand and in accomplishing their tasks of which some were manifested as follows:

"Actually they accept my idea kung baga wala sila naga reklamo, they accept, they are open for ideas wala sila ga reklamo gid when it comes to idea in return if they have an idea gina accept ko man…[They accept my idea without any complain at the same time I accept also their ideas…]" (Mary, line number 51-55, extracted from In-depth Interview).

Affirmation. Student affirmation plays an important role in making positive outcome in the PBS activities. It can be seen from the results of the transcripts that affirmation comes to play in the learning process specifically in the dynamics of the PBS activity in Electronics. Transcripts from the observations exemplified students' claim of understanding through the affirmation as suggested by each member of the group. Affirmation is important as revealed from students' responses in the following verbatim transcription that they contributed what they knew in order to accomplish their tasks:

"Well, mostly, we did is trial and error, we just try different patterns until we come up with the right one so that's the strategy that we use…" (Nelle, line number 58-61, extracted from In-depth Interview).

Assertion. Asserting ideas in PBS activities in Electronics helped students to explore and experiment ways to solve the problem. Ideas that were stated clearly and strongly were among the keys to make the PBS activities successful. Assertion is the most reliable action taken by the students in understanding the PBS activities in Electronics. The act of saying strong belief of ideas/suggestions/opinions in an activity plays an important role in solving PBS activities in Electronics. The following transcripts showed the statements of assertion of student Johna during the activity.

"Somehow dapat ang magnet ibutang ta ni sa tunga actually wala kami kabalo at first anu himuon namun sa magnet kung diin na siya namun e butang gin try namun nga gin try ang iban pa nga ways para mabutang ang magnet sa tunga and then amu na…[somehow, we need to put the magnet in the center, actually, we did not now it first on what to do with the magnet, where will we place it, we tried many ways then we put it in the center, that's it…]" (Johna, line number 42-49, extracted from In-depth Interview).

Assurance. Assurance is evident in the problem-based activity when the students converse about their ideas and some of them assured that these ideas could lead to the correct output. Students' assurance also plays an important role in making positive outcome in the PBS activities in Electronics. In addition, assurance plays an important role in the dynamics of PBS activities in Electronics as shown in the excerpts of transcripts below by Nelle who gives her assurance:

"Coil the copper wire to the mouth of the small jar. Make sure that the ends of the wire is extended. Stick the straw to the stick perpendicular to each other. Put the magnet at the end of the stretched straw and stick. Place the straw with a magnet and stick to the mouth of the jar. Put the ends of the copper wire. To test the galvanometer, the ends should be put on the positive and negative terminals of the 9V battery…" (Activity Sheet number 21, extracted from PBS Activity)

Familiarity. Familiarity of the materials were given attention in solving the activities. Students used their mind to remember the materials that were used by them. An activity similar to the PBS activities was conducted. Some of them familiarized themselves with the use of the materials and the PBS activity. They tried or used their familiarization of the materials in the activity that made them successful in solving the problems given in the activities as reflected in the verbatim transcript below:

"We first familiarize the materials and know what the purpose is. And I learned that if you started in wrong you end up in a mistake. In doing an activity, we should keep in our mind that we should have a cooperation and sharing the ideas…" (Journal Entry of Mary, line number 30-33, extracted from Activity Journal of Mary)

Effective communication. Effective communication plays a role in the PBS activities in Electronics when students were trying to converse with each other of their ideas/opinions/suggestions on how to solve the problem. These conversations were shown in the excerpts of transcripts below.

> *"We have learned that listening to others and good communication among team members, team work, accepting each opinion of your members will be very helpful in attaining the goal of your experiment…"* (Yanyan, line number 101-105, extracted from In-depth Interview)

Guessing. Guessing is also evident in the PBS activities of the students because PBS activities have no instructions or procedures to follow. Eventually, students will take a guess on what to do first. Some students guessed the functions of each material used in the activity. Guessing also plays an important role in PBS activities in Electronics. Guessing is exemplified in the following excerpts of the verbatim transcripts extracted from the journal entry of Mary:

> *"I think the Physics concept integrated is the electromagnetism. We coiled the wire first at the mouth of the bottle then connect it with the battery, we also connect the magnet through wire knowing that it will make the straw move. We shared that the wire should be connected to make the current from the battery travel around the wire. I understand the activity about the electromagnetism. The combination of electricity that ravel through the wire combined with magnet at the center their interaction to make the straw move. It gives us ideas on how to construct the improvised galvanometer…"* (line number 38-45, extracted from the Activity Journal of Mary)

Insistence. The act of demanding something or saying something in a way that does not allow disagreement is called insistence that is also evident in PBS activities in Physics. Insistence is also claiming that a person's idea is correct or it could lead to PBS. While a group of students were having a conversation to solve the problem, some of them were insisting their ideas as reflected in the following journal entry of Yanyan:

> *"Kinlanlan namun hibal-on ang purpose sang taga materials sang nabal-an namun sir nga na detect na niya ang current then amu na guru sir nga naglead kami into conclusion nga amu na ang galvanometer…[we need to know the purpose of each materials then we knew that it detects current and it lead to a conclusion that it is a galvanometer…]"* (line number 40-45, extracted from the Activity Journal of Yanyan)

Profess**.** The act of profess was very common to students who showed shyness. Their ideas/suggestions/opinions were hidden to themselves. Profess was also exemplified in the following excerpts of transcripts below:

> *"…and it made me feel that my idea is correct but my teammates did not listen to me…"* (Yanyan, line number 169-171, extracted from In-depth Interview)

Prior knowledge. Prior knowledge was often tapped in PBS situations related to concepts or events in past experiences. The utilization of this prior knowledge is in the context of the PBS activities to gain consensus, and accomplish the task. Prior knowledge was exemplified in the following excerpts of transcripts below.

> *"Actually, gin ubra ko sir para maintindihan ko ang problem kung baga bal-an sir, we already have a prior knowledge regarding this … [actually, in order to understand the problem, we already have a prior knowledge regarding this…]"* (Mary, line number 95-101, extracted from In-depth Interview)

Displays of Students Understanding

The practical circumstances of understanding how to go on with such a task must be relatively clear and specified for whatever counts as 'understanding' should be fairly straightforward. It was also found out that the displays of students' understanding were the following: assay of the students, their undertakings, and their realization.

Assay of students. Assay/Attempt of students plays an important role to understand more the problem being solved. This was exemplified in the following excerpts of transcript responded by Mary:

"Kay the first time nga nag attempt ko nga pa soundun ang speaker, wala gid nagsound and then I realize that my strategy was wrong ang strategy namun sir. Ang pinaka the best nga strategy nga gin himu we come up with a suggestion as a group nagcome up kami nga gin planuhan gid namun kung anu ubrahun gin tagpi tagpi lang namun…[The first time that I made an attempt to make the speaker sound, it did not make a sound. And then I realized that my strategy was wrong. The best strategy that we did was giving suggestion, as a group, we planned what to do then we connect all the materials…]" (line number 101-109, extracted from the In-depth Interview of Mary).

Students' undertakings. PBS follows a constructivist perspective in learning as the role of the instructor is to guide and challenge the learning process rather than strictly providing knowledge. In this case, students are considered to be active agents who engage in social knowledge construction. Students must have the responsibility for their own learning. In this study, students' encountered different undertakings in order to solve the problem. These students' undertakings in PBS activities further develop their understanding as responded by Nelle:

"Gina alternate ang aluminum plate kag ang water, tapos butang mu siya sa salt solution kag gamitan mo siya copper wire, e connect mu ang isa ka speaker ma work siya…[We alternate the aluminum plate and water then we put the salt solution and we use the copper wire to connect to the speaker. Finally, it works…]" (line number 85-89, extracted from the In-depth Interview of Nelle).

Students' realizations. The following excerpt shows that the student realized when the magnet was put in the coil of the copper wire, the improvised pointer moved. This is an example of student realization in solving PBS activities in Electronics as extracted from the responses obtained during Focus Group Discussion number 9:

> *"Sang nakita namun ang diagram or illustration, ga panumdum kami kung paanu namun e plastar visualize danay namun in the end, nagdecide kami nga mahimu mock up nga illustration nga another pa gid nga based sa breadboard pa gid, gin plastar namun in the end na realize namun nga indi naman gale needed, nagtry try kami kag mghimu sang ways para magpresent sang ubra at the same time helpful gid ang mga members kay damu sila inputs nga gin hatag kag useful man sa amun nga activity…[when we saw the diagram or illustration, we think of possible ways to put it all together, we visualize but in the end, we decided to make a mock-up illustration that is based in the breadboard. We put it together but in the end we realized that it is not needed. We try and make ways to represent our work at the same time our members are very helpful because they have lots of inputs given that is useful in this activity …]"* (line number 22-33, extracted from FGD #9)

The excerpt simply showed that when student saw the diagram in the activity sheet given to them, they visualized it but in the end they decided that they needed to make a mock-up illustration to further understand the problem. Unfortunately, they realized that they did not need the mock-up illustration instead they asked their group mates some ways to solve the problem and they also realized that members of the group were very helpful because so many ideas popped up inside their head. In this case, realization happened in the end when their strategy in solving the problem did not work. Therefore, students' realizations were very important to further understand the problem and to improve the ways in PBS activities in Electronics. These students' realizations were examples of the display of students' understanding.

Claims and Displays of Students that Built Interpretation and Understanding

Educators in a variety of educational settings—from K12 to the university classroom—have long used collaborative approaches to teaching and assessing students. More recently, educators and policy makers have identified the ability to collaborate as an important outcome in its own right rather than merely a means to an end. For example, the Partnership for 21st Century Skills has identified collaboration as one of several learning and innovation skills necessary for the success of post-secondary education and workforce. In fact PBS involving collaboration approach in teaching and assessing could enhance students' critical thinking skills.

Means of Students' Interpretation to Form Students' Understanding.

There are several reasons why it is interesting and practically important to achieve an improved understanding of the thought processes involved in using and learning scientific concepts. The interpretation of scientific concepts involves significant complexities transcending those of everyday concepts. Hence, it is particularly interesting to understand the underlying cognitive processes and to elucidate students' tacit knowledge in PBS activities.

Interpretation of materials in the PBS activities helped students in understanding the problems better. Students interpret the materials by knowing the functions of each materials to solve the problem. Some interpretations of students help in making the set-up works. Students gradually try their interpretations to make their output work. Students perceived understanding that the output is a simple thing that can produce sound/electricity/movements. Students also based their interpretations through the title and analyzed the concepts behind and it works. Students also interpreted the problem connecting all the ideas that they had learned as well as followed the schematic diagram. This was exemplified in the following cases:

Note: IR (Interviewer) IE (Interviewee)

Excerpts from verbatim transcripts of Case 1: Water Battery

IR Yes (.) how did you build understanding of the problem?

IE so that's why my interpretation of the water container should be used in the making of the project helped me understand the problem better.

Excerpts from verbatim transcripts of Case 2: Constructing a Galvanometer

IR Please tell me your understanding of the problem? (.) How do you understand the problem?

IE Understand nga ang galvanometer is a simple (.) thing nga maka produce

Excerpts from verbatim transcripts of Case 3: LED Flasher

IR Okay (.) how did you interpret the problem?

IE basta pag-interpret namun (.) ilugun gid namun ang diagram (.) mahimu gid namun ang LED flasher (.) kung insakto lang ang amun plastada sang tanan nga materials given.

Excerpts from verbatim transcripts of Case 4: Full Wave Bridge Rectifier

IR Okay (.) How did you use the instructional materials (.) or the materials (.) in the interpretation of your problem?

IE I interpret it through the title (.) how to make a full wave bridge rectifier (.) and of course (.) analyzing the concepts behind it (.) and how to make it work.

The results also showed that the claims and displays of students that built interpretation and understanding were shaping students' interpretation to form their understanding which built on the interpretation of materials by knowing the functions of each material to solve the problem and some of the interpretations of students helped in making the set-up works.

The following Figure 2 illustrates the "Yehey!" moments of students in achieving the correct output based on the transcripts generated by the researcher.

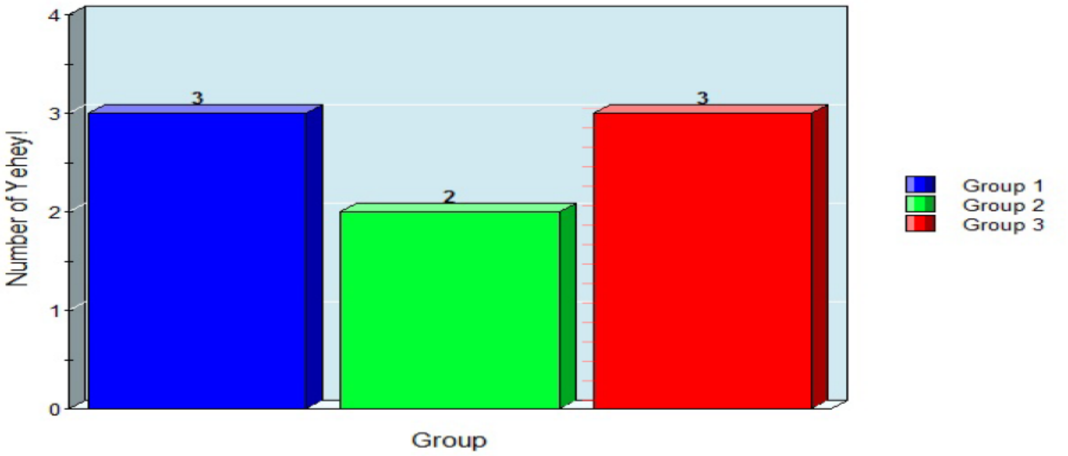

Figure 2. Yehey! moments of students.

Moreover, the practical achievement of understanding was relatively clear to them when the students attempted to find solutions to the problems. In order for students to understand the problem, they need to make some configurations on the instructional materials given to them. Most of the time, the students negotiated the correctness of the interpretations of the output produced. The configurations and the materiality of the outputs provided ample grounds for their assessments. They could see and point to what they considered to be mistakes and misunderstandings. The produced outputs showed the students' understanding of the interpreted PBS activity that made it possible for an instructor to move around in the room in search of publicly displayed misunderstandings.

Conclusion

Summary

This paper presented the dynamics of PBS activities in learning Electronics through the claims of students' understanding. These claims were achieved through their interpersonal exchange and contribution of ideas, the desired outcome of the learning objective, such as to build a water battery that could make a speaker sound, build an improvised galvanometer that can measure small amount of current, build a Light Emitting Diode (LED) flasher that can make LEDs light up like Christmas lights, and build a full-wave bridge rectifier that can convert Alternating Current (AC) into Direct Current (DC) from it in a short period of time.

Another important role in these PBS activities were to examine the claims of students' understanding that made them realize how learning can be made possible as well as have extended and yielded success in their learning experience. 'Actions speak louder than words' as the saying goes, these were also displayed by students' understanding in PBS activities comprising assay of students that displays their attempts or trials in solving the problem, students' undertakings that display their strategies or ways to solve the problem, as well as students' realization that displays their feelings, learnings, and experiences. Interpretation and understanding of students were put together through their claims and displays. These were shown through students' interpretations in building their understanding. This paper displays an achievement of students' understanding. On the other hand, it displays how instructional materials, task construction, and teacher interventions worked to make students' understanding in Electronics visible, accessible, and easy to recognize. Lastly, it highlights the inherent openness as to the criteria for assessing whether understanding has actually been achieved.

Implications

For theory. The findings of the present study have implications with explanation as anchored on the Theory of Brooks and Brooks that learners of all ages are more engaged in problems addressed in 'whole to part' forms (Brooks & Brooks, 1993). This concept allows for multiple-entry points and addresses multiple learning styles of students. Providing an interesting problem set or problem solving activity also creates a purpose for engagement versus the usual assignment of a chapter and end-of-chapter study questions. Students know at the outset where they are headed and finally achieved understanding.

In this study, the role of instructor is to change their perspective from teacher-centered approach by feeding students with knowledge into student-centered approach in which teacher is a leader and guide. The teacher points out the direction to solving the problem; offering the necessary experimental instruments for students and assisting the students to finish the tasks. The students also change from being passive receivers into active participants. The students become the main focus of the PBS. During a problem-solving process, the students learn the knowledge deeply. They do not only remember the knowledge but also develop critical thinking skills for such act is part of lifelong learning process.

For practice. The results of the study have significant implications on the following: Mentors, could be guided in choosing appropriate teaching approaches in teaching Physics, especially in Electronics. They could lay emphasis on students' strengths and weaknesses, constructive criticisms, interpretations, and students' understanding. This study may further serve as a point of reflection to improve styles in teaching Physics.

Students, may be motivated, encouraged, and made to realize the importance of their interpretations and understandings in answering PBS activities assigned in Physics lesson and in the context of real-life experiences. They would be further guided to improve their interpretations and understandings in solving Physics problems especially in Electronics, the topic that was researched upon in this study.

Instructional change is necessary in a college. In the past years, there were many developments highlighting research-based, classroom-proven 'best practice' teaching strategies which were accompanied by pioneering discoveries about learning and learners which are simply too compelling to ignore. With stand-and-deliver model of teaching and learning involving the instructor at the center of instruction, it is increasingly incompatible with today's youths who are expected to be independent learners. In some colleges or universities, ways to more varied methods founded on research about student learning are given and hopefully could be implemented successfully with more research evidences.

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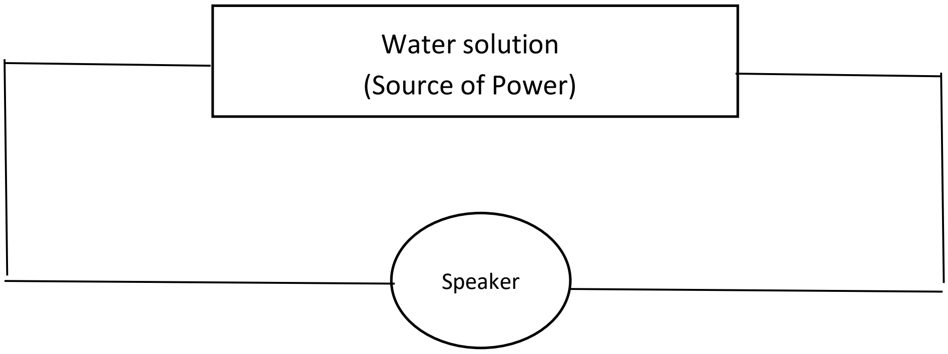
Appendix A: Problem-Solving (PBS) Activities

PBS ACTIVITY #1

Water Battery

Materials:

25 ml water container	20 g salt	10 cm connecting wires
1 pair of scissors	1 piece small speaker	100 mL water
2 pieces of aluminum plates	2 pieces of copper plates	1 piece plastic spoon
1 plastic cup		



Problem:

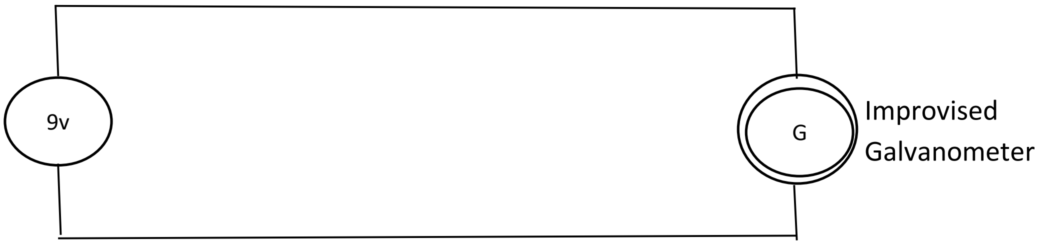
In Thirty (30) minutes, how can you make the speaker to sound from the materials given to you?

PBS ACTIVITY #2

Constructing a Galvanometer

Materials:

- Thin, insulated wrapping wire, 30 or 32 gauge, and scissors
- A small jar
- A round toothpick about 3 inches long
- A ceramic refrigerator magnet, about 1 x ¾ x 1/8 inch
- A plastic drinking straw, clay and masking tape
- 9 – volt battery



Problem:

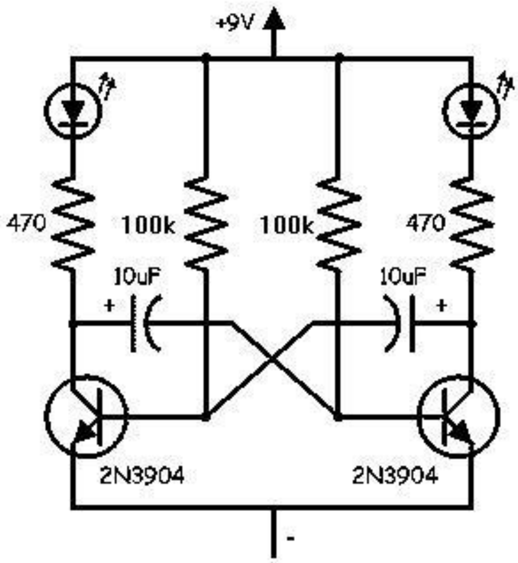
In thirty (30) minutes, how can you make a Galvanometer from the materials given to you?

PBS ACTIVITY #3

LED Flasher

Materials:

9-volt battery	connecting wires	2 pieces 100k Ω Resistors
2 pieces LED	2 pieces 470 Ω Resistors	2 pieces 10μF capacitor
2 pieces 2N3904 Transistors		



Problem:

In thirty (30) minutes, how can you make an LED flasher from the materials given to you?

PBS ACTIVITY #4

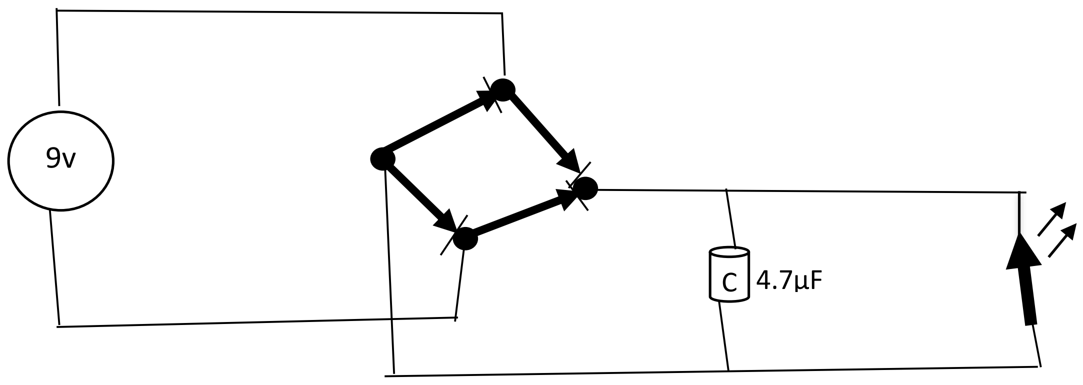
Full Wave Bridge Rectifier

Materials:

9 volt battery	4 1N4001 rectifying diodes	4.7µF capacitor
1 piece LED	1 Electrical cutter	
Breadboard	1 Electrical pliers	

50 cm connecting wire (color red)

50 cm connecting wire (color black)



Problem:

In thirty (30) minutes, how can you make a full wave bridge rectifier from the materials given to you?

Appendix B: Lesson Plans

Lesson Plan for the First Week

Date:	**Lesson Plan in Electronics** **SECOND SEMESTER** **S.Y. 2015-2016**
Objectives	1. Discuss the two laws of electrostatic charges. 2. Define coulomb. 3. Identify the unit used to measure current flow. 4. Discuss the relationship of amperes, coulombs, and time through a formula. 5. Explain how current flows in a circuit. 6. Explain how electrons travel in a conductor. 7. Discuss the three basic parts of a circuit. 8. Differentiate the three types of circuit configurations. 9. Explain how current flow can be varied in a circuit. 10. Explain Ohm's law with reference to current, voltage, and resistance. 11. Solve problems using Ohm's law for current, resistance, or voltage in series, parallel, and series-parallel circuits.
Subject Matter	CURRENT and OHM'S LAW *Reference: Gates, Earl D. (2012) "Electronics an Introduction". Cengage Learning Asia Pte, Ltd, Singapore*
Concepts	An electric **current** consists of the drift of electrons from an area of negative charge to an area of positive charge. The unit of measurement for current flow is the **ampere** (A). An ampere represents the amount of current in a conductor when one coulomb of charge moves past a point in one second. Two electrons together or two protons together represent "like" charges. Like charges resist being brought together and instead move away from each other. This movement is called *repelling*. This is the first law of electrostatic charges: like charges repel each other. According to the second law of electrostatic charges, unlike charges attract each other. Ohm's law describes the relationship among three fundamental quantities: current, voltage, and resistance. It states that current is directly proportional to voltage and inversely proportional to resistance.

Teaching Delivery (OBTL) **Outcomes Based Teaching and Learning**	*First Session* *Powerpoint Presentation *Lecture and Discussion *Interactive Presentation *Second Session* *PBS Activity No. 1: "Water Battery"
Assessment of Learning Outcome (ALO)	Paper and Pencil Test
Resource Materials	Powerpoint video and Worksheets
Time Allotment	3 hrs.

Lesson Plan for the Second Week

Date:	**Lesson Plan in Electronics** **SECOND SEMESTER** **S.Y. 2015-2016**
Objectives	1. Describe the two types of meter movements available. 2. Discuss how a voltmeter is used in a circuit. 3. Discuss how an ammeter is used in a circuit. 4. Discuss how an ohmmeter is used for measuring resistance. 5. Explain the functions of a multimeter. 6. Describe the advantages/disadvantages of DMMs and VOMs. 7. Discuss how to use a multimeter to measure voltage, current, and resistance. 8. Discuss how to measure current using an ammeter. 9. Discuss how to connect an ammeter into a circuit. 10. Identify some safety precautions for using an ammeter. 11. Discuss how to connect a voltmeter to an electrical circuit. 12. Identify some safety precautions for connecting a voltmeter to a circuit. 13. Discuss how resistance values are measured using an ohmmeter. 14. Define *continuity check.* cuss how an ohmmeter is used to check open, short, or closed circuits. 16. Explain power as it relates to electric circuits. 17. Discuss the relationship of current and voltage. 18. Solve for power consumption in an electrical circuit.
Subject Matter	ELECTRICAL MEASUREMENTS and POWER *Reference: Gates, Earl D. (2012) "Electronics an Introduction". Cengage Learning Asia Pte, Ltd, Singapore*

Concepts	In the field of electricity, accurate quantitative measurements are essential. A technician commonly works with current, voltage, and resistance. Ammeters, voltmeters, and ohmmeters are used to provide the essential measurements. A good understanding of the design and operation of electrical measuring meters is important. Meters are the means by which the invisible action of electrons can be detected and measured. Meters are indispensable in examining the operation of a circuit. Two types of meters are available. One type is the **analog meter,** which uses a graduated scale with a pointer. The other type is the **digital meter,** which provides a reading in numbers. Digital meters are easier to read and provide a more accurate reading than analog meters. However, analog meters provide a better graphic display of rapid changes in current or voltage.
Teaching Delivery (OBTL) **Outcomes Based Teaching and Learning**	*First Session* *Powerpoint Presentation *Lecture and Discussion *Group Activity: “Meter Reading” *Second Session* *PBS Activity No. 2: “Constructing a Galvanometer”
Assessment of Learning Outcome (ALO)	Graded Group Activity
Resource Materials	Powerpoint video and tinkering with circuits and devices
Time Allotment	3 hrs.

Lesson Plan for the Third Week

Date:	**Lesson Plan in Electronics** **SECOND SEMESTER** **S.Y. 2015-2016**
Objectives	1. Discuss the three categories of semiconductor devices that react to light. 2. Identify the major frequency ranges of light. 3. Discuss the major light-sensitive devices and describe their operation and applications. 4. Discuss the major light-emitting devices and describe their operation and applications. 5. Construct and label the schematic symbols associated with optoelectric devices. 6. Discuss the packages used for optoelectric devices.
Subject Matter	OPTOELECTRIC DEVICES *Reference: Gates, Earl D. (2012) "Electronics an Introduction". Cengage Learning Asia Pte, Ltd, Singapore*
Concepts	Semiconductors in general, and semiconductor diodes in particular, have important uses in optoelectronics. Here, a device is designed to interact with electromagnetic radiation (light energy) in the visible, infrared, and ultraviolet ranges. Three types of devices interact with light: • Light-detection devices • Light-conversion devices • Light-emitting devices The semiconductor material and the doping techniques used determine the relevant light wave-length of a particular device.
Teaching Delivery (OBTL) **Outcomes Based Teaching and Learning**	*First Session* *Powerpoint Presentation *Lecture and Discussion *Interactive presentation *Second Session*

	*PBS Activity No. 3: “LED FLASHER”
Assessment of Learning Outcome (ALO)	Paper and pencil test
Resource Materials	Powerpoint presentation and worksheets
Time Allotment	3 hrs.

Lesson Plan for the Fourth Week

Date:	**Lesson Plan in Electronics** **SECOND SEMESTER** **S.Y. 2015-2016**
Objectives	1. Discuss the purpose of a power supply. 2. Construct a block diagram of the circuits and parts of a power supply. 3. Discuss the three different rectifier configurations. 4. Explain the function of a filter. 5. Discuss the two basic types of voltage regulators and how they operate. 6. Discuss the function of a voltage multiplier. 7. Identify over-voltage and over-current protection devices.
Subject Matter	POWER SUPPLIES *Reference: Gates, Earl D. (2012) "Electronics an Introduction". Cengage Learning Asia Pte, Ltd, Singapore*
Concepts	Power supplies are used to supply voltage to a variety of circuits. Their basic principles are the same. The primary function of the power supply is to convert alternating current (AC) to direct current (DC). The power supply may increase or decrease the incoming AC voltage by means of a transformer. Once the voltage is at the desired level, it is converted to a DC voltage through a process called rectification. The rectified voltage still contains an AC signal, which is referred to as a ripple frequency. The ripple is removed with a filter. To ensure that the output voltage remains at a constant level, a voltage regulator is used. The voltage regulator holds the output voltage at a constant level.
Teaching Delivery (OBTL) **Outcomes Based Teaching and Learning**	*First Session* *Powerpoint Presentation *Lecture and Discussion *Interactive presentation *Second Session*

	*PBS Activity No. 4: "FULL WAVE BRIDGE RECTIFIER"
Assessment of Learning Outcome (ALO)	Paper and pencil test
Resource Materials	Powerpoint presentation and worksheets
Time Allotment	3 hrs.