

Students' Learning and Participation in a Case – Based Science Instruction

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Abstract— Physical Science is one of the courses being offered by any higher education institutions in the Philippines to make non – majors knowledgeable about concept and principles that govern physical world through case – based science instruction. Thus, this paper used participatory action research with application of the framework of Action Research Spiral to investigate how students learn and participate in this method of teaching. It was found that case – based science instruction is an informative method of teaching requiring students to get involve on real situation by suggesting possible solutions through knowledge of Physical Science. Likewise, students' participation was described as means, ways or strategies to analyze and suggest possible solutions in the light of their prior knowledge and learning gained in the discussion to demonstrate in depth understanding on nuclear power generation. Based on the findings, a model for the use of this method is proposed.

Keywords— case – based science instruction, Physical Science, students' learning, students' participation.

I. INTRODUCTION

PHYSICAL Science is one of the General Education subjects being offered by any higher education institutions in the Philippines. To earn a four – degree course, students must enroll and pass the subject. To make the students particularly the non – majors knowledgeable of the concepts and principles that govern physical world is the main goal of the subject.

As an institution of higher learning, De La Salle Lipa is utilizing the concept of Transformative learning which is based on the constructivist framework that considers learning as a personal process that happens within and to the learner. Thus, it was proposed that for the Second Semester of School Year 2013 – 2014 classes of Physical Science used case – based science instruction.

Case – based science instruction has gained strong foothold in science education (Herreid, 2005).¹As what Herreid (2005) explained, this method of teaching relied on cases that were largely self – contained stories that tend to be short and

relevant to the students and pose a dilemma. Likewise, there are many forms of case – based science instruction, however in this proposed study will only focus on small group cases in which a case will be given to a small group to analyze and them a team representative will report on the group's deliberations.

Studies showed that using case studies improves students' performance. Herreid (2005) emphasized that this promotes greater learning and retention in verbal and mathematical skills and students enjoy the experience more, have better attitudes toward the subject, develop better social skills, become more articulate and more tolerant of differing viewpoints than with the lecture style (Herreid, 2005). Yadav, et al (2007)²in their study entitled "Faculty perceptions of the benefits of case teaching" found that students gained much from cases and participation of students increased when cases were used in class. Likewise, based on the same study students took an active part in the learning process and they did not encounter any difficulty working in a small group. In the study of Yadav, et al (2007) entitled Implementing the Case Teaching Method in a Mechanical Engineering Course it was found that Case-based instruction can be beneficial for students in terms of actively engaging them and allowing them to see the application and/or relevance of engineering to the real world.

Herreid (2005) shared that in a survey among faculty members that made use of case teaching in the classroom observed that 97 percent students learned new ways to think about an issue; 95 percent reported that students took a more active part in the learning process; 92 percent mentioned that students were more engaged in class; 84 percent reported that students were glad case studies were being used, 59 percent were more likely to do independent research outside the classroom to improve their understanding of the material; and 68 percent said students d more in classes using case studies.

Considering all the things cited above, the researcher conducted this study on case – based science instruction. Likewise, the researcher also take into consideration that part of case teaching is storytelling which is an example of a formal educational device which permeates the human experience (Herreid, 2005). In addition, the researcher has been utilizing this device in teaching various topics in the subject Physical Science particularly on geological concepts to provide students concrete examples that govern nature. Thus, the researcher believes with what Herreid (2005) mentioned that discussing cases leads to a meaningful learning and as what Golich, et al

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(2000)³ emphasized that case teaching places students at the center of educational process. Likewise, Yadav, et al (2007) stated that case studies have been found to increase students' critical thinking and problem-solving skills, higher-order thinking skills, conceptual change, and their motivation to learn. Although there are numerous surveys conducted on the use of case teaching, the researcher had not yet encountered similar study in the Philippine setting. Thus, the researcher believes that this study added in-depth knowledge and understanding on the use of this method.

II. METHODOLOGY

This study on students' learning and participation in a case – based science instruction utilized qualitative method of research particularly participatory action research in which the researcher conducted focus group discussions among respondents to acquire ⁴⁵adequate data as bases for in – depth analysis. Likewise, the researcher relied on observations during the conduct of the study.

The participants of this study were 162 second year business students who were enrolled in the four sections of Physical Science class during the Second Semester of School Year 2013 – 2014, De La Salle Lipa, Lipa City Philippines. They were chosen as respondents of this study because they were not science majors and were only enrolled in the subject not only to comply with the four year degree requirement of the Commission on Higher Education of the Philippines to be conferred with a degree but to enable them to develop into scientifically literate citizens in the future.

This study also made use of the action research spiral which involved spiral of planning, acting, observing, reflecting and re-planning and so round the spiral again.

To conduct the study the participants were taught using case – based science instruction in which the students were required to form small groups with three members and were given a copy of a case on the present condition of the only nuclear power plant in the Philippines which is the controversial Bataan Nuclear Power Plant. This power plant was highlighted in the lesson on sources of energy specifically nuclear power because of the existing argument in all sectors of the Philippine society on whether it will be opened or it will be forever mothballed. Likewise, its location which is according to studies is presently situated along a fault line in Bataan, Philippines was also looked into with regards to safety of the society. Thus, in the conduct of this study application of

concepts learned in both Physics and Geology particularly Seismology were given emphasis.

The main instrument of this study was a guide question used during the focus group discussion to acquire the needed information in this study.

Focus group discussion was conducted during the students' respective schedule of classes in the subject Physical Science after analysis of case study had been conducted and discussion in the classroom had been facilitated.

Analysis of data was done through axial coding technique.

III. RESULTS AND DISCUSSIONS

A. Students' Learning in a Case – Based Science Instruction

Students learned a lot in a case – based science instruction. This was proven by the fact that students gave various meanings to this method of instruction. According to one of the students, case – based science instruction focusing on Bataan Nuclear Power Plant is *“a very informative method of teaching that serves as an eye opener for students that there are already problems going around”*. Another student defined this as method of instruction that *“shows real situation in our country”*. It was also defined by another student as *“a means by which learners become involve in solving current social issues that can be solved through knowledge of Physical Science”*. To further define case – base science instruction, a student stated that this method *“enables students to be aware on shortage of energy and be able to make a stand, thus take action on it in which nuclear power is an option”*.

It was observed by the teacher – researcher that when case – based science instruction was introduced among students to understand nuclear power generation, they were able to apply or link what they learned in the discussion about the topic and with the situation cited in the case. Likewise, many students participated during the discussion and shared a lot of information about Bataan Nuclear Power Plant. Some of them reacted that they were surprised to learn that this source of energy is located along a fault line and were alarmed that anytime earthquake may occur. Others questioned government's decision to allow its construction on this earthquake prone area. Thus, students were right for saying that this method of instruction is not simply applying concepts in class through presentation of real life case but an eye opener to future citizens of the country that will affect, strengthen or change ones decision in the light of human welfare.

The above findings were supported by Popil (2010) ⁶who emphasized that case – based teaching stimulate critical thinking while allowing students to apply new concepts immediately to real – world situations. Likewise, it was stated in the Teaching Handbook of Indiana University (2014) ⁷that cases challenge participants to analyze, critique, make judgments, speculate and express reasoned opinions. Moreover, Yadav, et al (2007) stated that students have a

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better grasp of the practical application of core course concepts through case – based science instruction. Furthermore, Davis and Wilcock (2003)⁸ explained that the use of case studies allows the application of theoretical concepts to be demonstrated, thus bridging the gap between theory and practice.

To learn nuclear energy using case – based science instruction, students claimed that they made use of various strategies. Many students shared that they learned by “*enumerating the many importance of nuclear power generation*”. There were some students who explained that they learned the lesson “*by answering questions they had in mind and even became more curious about this topic*”. They said that they “*were able to connect all knowledge learned in class with the present situation of nuclear power generation in our country*”. There was a student who explained that this method of instruction made her “*think on the topic and apply knowledge learned during the discussion while analyzing the given case on Bataan Nuclear Power Plant*”.

As observed by the teacher – researcher, students were able to participate during the classroom discussion through answering given questions specifically on the importance nuclear power generation. However, when asked whether Bataan Nuclear Power Plant which is the only power plant in the Philippines will be allowed to operate, almost half of the class was half – hearted. Some of them strongly believed that its operation will supply the needed amount of energy in most parts of the country while almost half of them claimed that there is no assurance that safety of the people will be safeguarded particularly the place is along a fault line which may result to leak and nuclear radiation once earthquake occurs. Thus, many students were wondering why the government had not looked into this situation before the construction of this building. Indeed, students learned to question and analyze the situation in the light of the lessons in Physical Science before making any decision or judgment as they applied various strategies to understand the lesson.

Yadav, et al (2007) added that case study teaching enabled students to develop deeper understanding of the topic. Thus, Herreid (2005) explained that through case studies, students’ positive attitudes toward the subject matter increases. It is also worthy to emphasize that cases are important for bringing real world problems into a classroom - they ensure active participation and may lead to innovative solutions to problems (Indiana University, 2014).

In terms of consequences, almost all students claimed that through case – based science instruction as applied in learning nuclear power particularly on Bataan Nuclear Power Plant, they “*learned the advantages and disadvantages of constructing a nuclear power plant*”. Other students claimed that they “*thought about pros and cons of resorting to nuclear power*”. There were students who shared that analyzing the case of the only nuclear power plant in the Philippines “*gave*

them ideas on merits and demerits of resorting to nuclear power”. Some students said that they “*gained information on the issues concerning Bataan Nuclear Power Plant*”. They expressed that “*they learned about the current status on Bataan Nuclear Power plant*”.

As what had been observed, students were able to clearly explain the advantages and disadvantages of allowing Bataan Nuclear Power Plant to operate in a very comprehensive and clear manner. They were able to give many scenarios on what probably may happen if the country will resort to nuclear power generation. They never forgot the data presented in the case as they always mentioned about its location which is along a fault line. The teacher – researcher believed that the previous statement will always be remembered by the students as this surprised them as they analyzed the case. They also shared that since elementary they were already familiar with this possible source of energy but they were not thought of this scenario. They just knew its location but not the real situation. Thus, case – based science instruction unlighted students on many issues, things or scenarios to consider before coming up with a sound decision and judgment.

The above findings were supported by Yadav, et al (2007) that case teaching enabled students to have a better view of an issue from multiple perspectives and make connections across multiple content areas. Likewise, Davis and Wilcock (2002) emphasized that case studies are, by their nature, multidisciplinary and allow the application of theoretical concepts, building the gap between theory and practice.

They were also students who stated that they “*became aware on the debate whether to operate or not to operate Bataan Nuclear power plant*.” Others “*became interested to re-open nuclear power plant*.” They said that they “*became aware that there is an existing nuclear power plant in the Philippines but since it had been constructed – it never operate*”.

These statements had been supported by the observation of the teacher – researcher that there were still some students who were surprised to learn that Philippines has only one nuclear power plant compared to any countries in the world; however, this power plant never operates at all. They shared during the discussion that when they were studying this topic on nuclear power plant in the country, Bataan Nuclear Power Plant had been always mentioned and they already memorized this fact by heart. However, going to every detail of it was not been done. Thus, they were really surprised and their attention was caught when after enumerating all the advantages and disadvantages of nuclear power generation, they learned about its location and they came into conclusion that several studies should be conducted first before the construction of this source of energy particularly on where to put this building in which the safety and health of the people are given priority.

Herreid (2005) supported the above findings by stating that the use of case teaching in the classroom enabled students to learn new ways to think about an issue and took a more active part in the learning process.

In addition to the consequences mentioned above, many students claimed that through case – based science instruction on the topic nuclear power as a source of energy they “*learned*

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how much it cost and energy produce to supply electricity needs of a certain area". They "became aware of different problems and different solutions regarding sources of energy". Other students said that "they learned that nuclear power plant is very hazardous." This claimed is made stronger as one student stated that "this method made her understand how dangerous a nuclear power plant is". On the other hand, a student contradicted the above claimed by stating that "nuclear power plant is safe because it only gives out steam but it will be harmful when the nuclear reactors malfunctioned". A student added to the previous statement that "everyone should not forget that it is very important also to examine the location of this nuclear power plant – along a fault line which can be a possible cause why an earthquake may occur and if happens nuclear leak and radiation follows". Thus, a student made this reminder that "there is a need to weigh possibilities of allowing the power plant to operate". In addition, a student stated that analyzing case like Bataan Nuclear Power Plant "made one see and know the different sides why there are people who are against and in favour that Bataan Nuclear Power Plant operate."

It had been observed by the teacher researcher that during classroom discussion, students were very eager to discuss the advantages and disadvantages of generating energy from nuclear power as if they already memorized them. Some of them commented that they studied them when they were in high school so the lesson was only a review. However, the difference now was that they were able to provide evidences like news articles on what happened in different parts of the world that depend on nuclear power as source of energy. When asked why they have to provide these evidences, they claimed that they would like to confirm the data or situation stated in the case given to them to analyze because many of them were puzzled, alarmed and surprised of the real situation. Thus, the use of case – based science instruction enabled them to look into details of the situation and challenge their way of thinking before they made a decision whether they are in favour of its operation or not.

Popil (2010) supported the above statements by claiming that case – based teaching enabled students to develop reflective judgment concerning an issue. Likewise, Yadav, et al (2007) added that through this method of teaching, students increased their discussion on social issues.

As experienced by the Physical Science students, they shared that using case – based science instruction in Physical Science class "enlightened them to be firm with their decision to support or not the operation of Bataan Nuclear Power Plant." Others said that "this method helped them to make a stand whether nuclear power plant should operate or not".

According to some students they "learned new things about nuclear power plant in the Philippines". They said they "became aware that there is nuclear power plant in our country but had never allowed to operate". Likewise, there were some students who claimed that they "became updated on current issues being talk about on nuclear power generation and how they are addressed by the government". With these scenarios, some students added that they "came to

realize the real story behind the construction of Bataan Nuclear Power Plant".

As observed, students really learned from using case – based science instruction as they manifested attentiveness and interest in the lesson during classroom discussion. This was evident through the way they answered questions given by the teacher. There were students who explained answers by citing concepts and principles learned in Physics and Geology as well as events in Philippine history to trace the idea of building power plant in the country. Likewise, there were also students who gave update on what is the next plant of the present Philippine government regarding the mothballed power plant which led to a sort of debate in class. Thus, it can glean from these observations that students did not only learned concepts and principles in learned in the subject they enrolled in but they were able to relate them to other subjects like social sciences. In the process, students were able to see how Physical Sciences particularly Physics and Geology applicable to all aspects of one's existence.

The above findings are supported by the report of Herreid (2005) that when students were exposed to case teaching they took a more active part in the learning process and were more engaged in class. Thus, these findings were indeed realistic for saying that case – based science instruction provide a meaningful learning experience among students.

Through analyzing the case of Bataan Nuclear Power Plant, students shared that they "clearly understand the lesson on nuclear energy". They said that they "now knew the real purpose why Bataan Nuclear Power Plant was constructed". Likewise, students enunciated that case – based science instruction enabled them to "learn how a nuclear power plants works". Others said that they "learn not just the technicalities on how nuclear power plants work but also its application to real life situations". Some claimed that they "gained new learnings about the effects of nuclear energy in a certain location where there are lots of people residing". Through this realization, many students emphasized that this method of instruction "helped them understand why Bataan Nuclear Power Plant did not operate". This claimed was made stronger as one student expressed that studying the case "gave them an idea on facts that surround this mothballed power plant and was able to better understand how it work and its devastating effects". Likewise, there were students who agreed with this claimed that case – based science instruction "gave them opportunity to express my opinion whether to let Bataan Nuclear Power Plant operate or not". In same way there were students who shared that this method of instruction "provided various ideas and arguments which made me interested on the topic nuclear energy more". In addition, one student expressed that he "became concern about our country that if we will not to get energy from nuclear power plant there will be a lot of instances of brown outs or black outs which affects a lot of Filipinos". Thus, most students agreed that this method "made them knowledgeable about nuclear power generation".

As observed, students became interested in the topic nuclear energy. It was also observed that almost all students reacted to the idea on the location of the power plant in the

Philippines. Some of them questioned why many people were not informed that this power plant is along a fault line and why this important thing was not discussed when they were in elementary and high school so that since the beginning they reacted already and will not think twice not to operate it if given the chance to participate in decision – making. One student reacted that this is very important information that every citizen should be aware of so that they will be enlightened.

As explained by Herreid (2005) case teaching promotes greater learning and retention in verbal skills and students enjoy the experience more, have better attitudes toward the subject, develop better social skills, become more articulate and more tolerant of differing viewpoints than with the lecture style.

According to some students studying Physical Science through case – based science instruction “*tested their analytical skills on how problems on sources of energy be solved*”. Others shared that this method “*helped them to think critically and analyze harder situations*”. Based on the experience of one of the students, analyzing case on Bataan Nuclear Power Plant “*shook his head on different ideas on nuclear power plant*”. There were students who claimed that this method “*enhanced ones analytical and critical thinking whether to reopen or dump the mothballed nuclear power plant which students often neglected before*”.

It was observed during the small group discussion on the case given to the students that every member of the group was able to share their insights and ideas concerning the topic. However, it took time for the groups to discuss what the case was all about and the dilemma and possible solutions to the problem. Thus, it took an hour to end the small group discussion. When asked some students replied that their familiar with the topic; however, they were flooded with a lot of new information such as the location of the power plant and the expenses incurred in the construction leading to a little confusion whether to let it operate or not.

The above findings were supported by the statement from The Center for Research on Teaching and Learning (2014)⁹ that case – based teaching enabled students to develop analytical thinking skill. Likewise, Popil (2010) added that case studies as teaching method promote critical thinking among students.

There were students who said that using case – based science instruction “*enabled them to become aware of environmental effects of using harnessing energy through nuclear power plants*”. Some students said that “*this method encouraged them to really take care of the environment while generating nuclear power*”. As what one student shared that she came to “*realize that it is really expensive and dangerous to build a nuclear power plant*”. Likewise, a student explained that she “*became aware that even though it would be a big help to citizens there are still lots of disadvantages to be considered*”.

Many students shared that through case – based science instruction they “*gained more knowledge on social issues*

related to the subject Physical Science”. This “*enhanced their knowledge about nuclear power plant with political rivalry involved*”. In addition, a student stated that this method “*exposed them to possible source of energy such as nuclear power but the government does not give much attention to this matter*”. There were also students who said that analyzing case “*gave students ideas of what really is the effect of nuclear power to our economy*”. Thus, as explained by one of the students “*gave them different perspectives regarding nuclear power generation*”. There were also students who emphasized that this method helped them “*understand that if Bataan nuclear power plant will be allowed to operate, people will spend less money on electricity bills*”. Likewise, as experience by one of the students, analyzing case “*opened her mind about the possibility of having less electric bill and nuclear power plant could be of great help but still the danger is there because nuclear power is hard to manage*”. Another student shared that “*before she knew that Bataan Nuclear Power Plant is closed due to dangers it entails but now she understands that this source of energy is also beneficial to humans*”. It is also worthy to look into one of the students realization that through this method of instruction she was able to “*consider the importance of saving energy*”. One student added that “*there is a need to identify various ways to conserve energy for the coming generations and bring about innovations and ideas that will benefit everyone*”. Thus, most students concluded that this method of instruction “*made them more concern with how energy can be used wisely*”.

It was also observed that students had already mastered the lesson on nuclear power generation because they were very articulated in answering questions during the discussion. They were also very active in class by raising questions to clarify some points. There were also students who shared not only what they learned but their opinions and reactions concerning the construction of the power plant. Others were very honest to admit that now they were confused whether they are in favor or not of its operation. There were also students who reacted that it is better to look into the experiences of other countries so that we may learn from them and enjoy the benefits we can get if we will allow Bataan Nuclear Power Plant to operate taking into consideration its geological impact.

Popil (2010) agreed with the findings above by stating that case studies facilitate and promote active learning. Likewise, Herreid (2005) stated that promotes greater learning and retention.

In using case – based science instruction among students of Physical Science on the topic nuclear power plant it was shared by one of the students that in terms of condition she “*was intrigued about Marcos’ and Aquino’s stand during their administration that this issue arose even I do not like to study history*”. This was further strengthened by the claimed of another student who said that “*the case on Bataan Nuclear Power Plant was interesting*”.

As observed, that a non – science major explained concepts on nuclear power generation in details as if they were experts in the field. She did not only explained the concepts in Physics governing the operation of nuclear power plant as

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nuclear fusion but also explained its geological implications whether its location is really dangerous which is along a fault line. The said student also suggested that this will not be a problem if we only benchmark with countries with nuclear power plant which are found along the Pacific Belt of Fire such as Japan. Evidences were also provided by the students to prove their claim whether to operate it or not. Thus, students were able to look on both sides of things and consider broader perspectives to come up with sound decision and judgment concerning an issue.

Herreid (2005) shared that use of case teaching in the classroom enabled students to learned new ways to think about an issue; that students took a more active part in the learning process; they were more engaged in class; were glad case studies were being used and more likely to do independent research outside the classroom to improve their understanding of the material.

B. Students' Participation in a Case – Based Science Instruction

Students participated in various ways in a case – based science instruction. This was evident in terms of meaning given by students to this method of instruction. As defined by one student, case – based science instruction refers to a “*method that gives students lots of information on Physics and Geology concepts and principles related to nuclear power generation through real life situations specifically in the Philippines*”.

The meaning given above was supported by Herreid (2005) who explained that case – based method of teaching relied on cases that were largely self – contained stories that tend to be short and relevant to the students and pose a dilemma.

There were various strategies employed by students who participated in this method of instruction. Most students shared that they “*read the case on Bataan Nuclear Power Plant many times*”. As what one student stated, she has to “*read the case between the lines to understand every detail of it*”. One student cited that it is important that one should focus on the article while analyzing the case”. Likewise, as stated by another student, “*if you focus on the case, main problem can be identified to suggest possible solutions. Thus, a student shared that solutions can be suggested by “following the steps involved in scientific method as emphasized in the science class”*”.

It was observed that students allotted time to read the case given to them. They tried their best to think of possible solutions to the problem or dilemma at hand. Thus, it took them almost an hour to analyze the case and they even allotted time to conduct research to understand better the case and propose possible solutions to the problem. Thus, a student commented that she had already mastered the lesson and when she heard or encountered the word energy she will always think of nuclear power generation in the Philippines.

The above findings were supported by Herreid (2005) who emphasized that students took a more active part in the learning process as this method of teaching that permeates human experience. Likewise, the Association of American

Colleges and Universities (2015)¹⁰ enunciated that case studies are a good vehicle for encouraging students to carry out independent research outside of the lecture or tutorial environment.

Some students claimed that they participated in a case – based science instruction “*by looking into important points in the case*”. Likewise, there are students who shared that “*they picked some important details in the case to solve the dilemma*”. Moreover, some students said that they “*marked important details in the case.*” On the other hand, many students expressed that they “*conducted research about whether the Bataan Nuclear Power Plant will operate or not*”. When asked why they had to do this, they claimed that “*they need to verify facts to know the reason why this power plant is not allowed to operate*”.

It was also observed that students were very active in class and they knew every detail of the lesson. They even cited some news articles concerning nuclear power generation. Thus, when case – based science instruction was used in class it can be said that students participated in the learning process by providing evidences to show to solve the dilemma presented in the case.

The above findings were proven by the statement of Popil (2010) that case – based teaching promotes active learning.

This is proven by Herreid (2005) that through case teaching, students are more likely to do independent research outside the classroom to improve their understanding of the material.

Many students cited that after they read the case they “*shared their opinions on the topic with the members of their group*”. Some students who claimed that they “*tried to understand others' opinion no matter how vague and different others' views from them*”. There were students who shared that they even “*conducted a debate with their group mates because they came to a point that they can not reconcile their ideas, views and reasons why Bataan Nuclear Power Plant should not be allowed to operate*”.

As observed during classroom discussion, students were very active and they were willing to share to the class their opinions on whether to allow Bataan Nuclear Power Plant to operate or not considering its location. Likewise, everyone was listening without interrupting someone who was talking. This was a way to say that even they had varied opinions on the topic, they were able to show respect to one another. Thus, students became interested in the lesson and were able to manifest acceptance of varying points of view.

Yadav, et al (2007) proved the above findings by stating that case teaching enabled students to develop positive peer – to – peer relationships. Likewise, the same authors added that case teaching enabled students to have a better view of an issue from multiple perspectives. One strategy that most students employed to analyze case on nuclear power generation in the Philippines is to “*state the advantages and disadvantages as well as weigh the pros and cons if this will be allowed to operate*”. There were some students who stated that they had to “*understand facts and benefits if the*

¹⁰ Association of American Colleges and Universities is the leading national association concerned with the quality, vitality, and public standing of undergraduate liberal education.

nuclear power plant will be opened and analyze the present situation in our country". Likewise, a number of students "relate the case to the lessons in Physical Science on nuclear energy generation".

There were some students who emphasized that to analyze case they need to recall concepts learned in Physical Science. In addition to this statement, a student mentioned that he "realized and connected concepts learned in Physical Science with social issues specifically on nuclear power operation in the country". Some students argued that "there was a need to capitalize on one's background knowledge to reflect on the lesson learned in the subject and find its relation to the case".

As observed during class discussion, students even mention socio – political concepts which made their claims even stronger. Through these claims and evidences, they were able to suggest possible solutions to the dilemma at hand as they consider the applications of concepts learned in Physical Science particularly in Physics and Geology.

Yadav, et al (2007) agreed with the above findings by stating that case teaching enabled students to make connections across multiple contents. Herreid (2005) added that students do more in classes using case studies.

One strategy that students also used to analyze the case of the only nuclear power plant in the Philippines was "to look into the environmental effects of allowing this to operate. One student enunciated that she had to "contemplate on the case and put oneself on the shoes of every person who will be affected by the operation of the nuclear power plant". Another student added that she has "to think of the situation like as if I am one of the citizens residing near a nuclear power plant and how will I be affected by this source of energy" A student reminded everyone that "everyone should bear in mind that this case is very important as this is the concerned of everyone".

As observed, many students shared that they thought of what will happen if Bataan Nuclear Power Plant will be allowed to operate. Will there be possibility of leak from it? Will it emits radiation to its surrounding? What if earthquake occurs as this power plant is built along a fault line? If earthquake occurs, will Bataan Nuclear Plant be like the nuclear power plants in Japan that are resistant to such natural phenomenon? Indeed, classroom discussion was flooded with a lot of questions pertaining to dilemmas at hand.

The Center for Teaching and Learning (2014) supported the above findings and claimed that case – based teaching enabled students to manifest reflective judgment on real – life scenarios. Thus, discussing cases lead to a meaningful learning (Herreid, 2005).

It is also worthy to mention that there were students who cited that while analyzing cases "one should become interested on the topic nuclear power generation in the Philippines". One of them added that "let one's imagination works for it will do wonders to come up with sound judgment whether to allow this power plant to operate or not considering its Geological implications". Another student gave this advice that one should "know the topic by heart; put your heart into it; and read the case with one's heart". As

what one student added "let the article sinks into once consciousness".

It was observed that indeed students focused on the lesson and this triggers their interest to learn more. They even asked questions during the small group and classroom discussions while they were able to link the lesson to their prior knowledge.

To support the above findings, Herreid (2005) emphasized that case teaching enabled students to be more engaged in class and were glad case studies were used in class.

In terms of condition, students' participated in a case – based science instruction although they claimed that this method "was hard as one was required to think about nuclear power plant generation in the country and there are a lot of things to consider". There were also some students who found that "it was really difficult to analyze cases because one has to look into many important details which somehow lead to confusion". However, a student shared this observation that "there must be assurance that everything stated in the case was familiar with them". A student agreed with the previous statement by adding that "it was difficult to analyze the details stated in the case if you can not understand how this source of energy is being generated".

It was observed that students enjoyed working and sharing with their group mates their opinions on the lesson although there were many times their opinions differ from one another. This can also be attributed to the fact that the case that was required from them to analyze was familiar to them although students claimed that they gained important things about Bataan Nuclear Power Plant on concepts and principles in Physics as well as in Geology that will enable it to generate energy.

The above findings contradicted the claims of Yadav, et al (2007). The aforementioned author stated that students' difficulties in a case teaching was more on working with small groups; however, in this study students did not experience the said difficulty as explained by Herreid (2005) case teaching promotes social skills among students.

As a consequence of participating in this method of instruction, a student realized that "it should be better to understand the case if students will open their minds on the present situation in our country specifically on energy generation".

This is proven by the statement of Golich, et al (2000) that in a case teaching, students learn facts, acquires requisite life long learning skills of analysis and collaboration. Likewise, educators consistently cite critical thinking as the important skill case studies inculcate in students (Stanley and Waterman, 2015).¹¹ Moreover, the Association of American Colleges and Universities (2015) found out that case – based approach is useful to develop transferable skills such as individual study skills, presentation skills and practical skills.

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To summarize, it can be gleaned that case – based science instruction is described by students as an informative method of teaching which required them to get involve on real situation as presented in the case faced by the society by suggesting possible solutions through knowledge of Physical Science particularly Physics and Geology. Likewise, students' participation can be described as a means, ways or strategies to analyze and suggest possible solutions to problems in the light of their prior knowledge and learning gained during classroom discussion to demonstrate in depth understanding on nuclear power generation through real life situations. Thus, students will be trained on how to come up with sound decision and judgment.

Based on these findings, a model of case – based science instruction is being proposed as shown in Fig. 1.

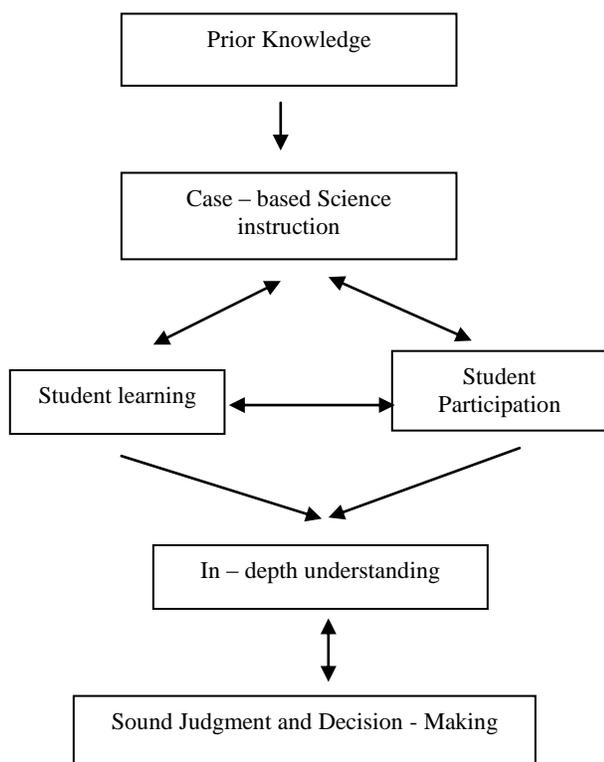


Fig. 1 Model of case – based Science instruction

Fig 1 shows that in a case – based science instruction students learn the topic by providing them with real life situation in the form of cases to be solved using concepts learned in the subject as well as prior knowledge gained. As students work in small groups, learning takes place by reading the case, research on it to verify facts, analyze the situation and share one another's point of view. Through these, students will acquire in – depth understanding of the lesson as they solve realistic problems which serves as their training how to make sound judgment and decisions. As pronounced by Angelo and Boeher (2002)¹² case learning engages students

with the course material, encouraging them to “see it from an action perspective, rather than analyze it from a distance”. Likewise, Golich, et al (2000) emphasized that in case teaching, students are asked to learn the theory, but also to apply it to the messiness of the real world. Moreover, Herreid, et al (2012)¹³ found out that since best cases are based on contemporary and often contentious, science problems that students encounter in the news, the use of cases in the classroom makes science relevant.

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