

Challenge-Based Learning Approach in Research (C-BLAR): Thinking –out-of-the-Box Through Creating Community-Based Research Projects

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Abstract— This study pioneered the application of Challenge-Based Learning Approach in Research (C-BLAR) in Science, Technology, Engineering and Mathematics students. This approach in research stimulates creativity of students to think out of the box; sensitive to community-based problems like environmental problems and the like by designing research projects in order to address such problems. The purpose of this study was to evaluate how C-BLAR specifically in Practical Research 2 affects students' creativity in designing community-based research projects. A total of 72 respondents (n=72) were evaluated of Grade 12- STEM of the Misamis Occidental National High School, Oroquieta City. The respondents were grouped into two (2) namely; control and experimental. In each group there were 36 students which were grouped into six (6) and having six (6) members each. As a result, both groups were able to come up with research projects. Surprisingly, all of the research projects in the experimental group were timely and showed positive contributions to community-based problems. The theme of their projects promotes green environment such as reducing noise pollution, ecobag out from wastes, alternative papers from wastes. In addition, there is a significant difference between the groups in terms of creative ability ($p=0.000$), scientific thought ($p=0.001$), thoroughness (0.001) and skill (0.002) which made the approach effective. It showed also that learners were positive on their experiences on the subject and the approach used as stated evidently on their interviews. Research findings suggest that research must be contextualized and community-based in any strand of Senior High School.

Index Terms— STEM, C-BLAR, community-based research projects, reflection, practical research, skill, green environment

Introduction

In today's generation, environmental problems are prevalent. Typhoons and other climatic conditions are surprisingly destroying thousands of lives and properties. According to the Report on Climate Change Policies (2010), Philippines is said to be the hotspot for climate change disasters like agricultural crop production and food security due to extreme El Niño and intense tropical cyclones. Recent scientific studies reveal that human activities have contributed significantly to the increase of greenhouse gases in the atmosphere that causes climate change that lead to interconnected environmental issues. With this concern, environmental education connects us with the world that surrounds us and teaching us awareness.

In classroom setting, environmental education is integrated in various disciplines which allow learners to be educated with the community problems. The problem with this, learning of these stuffs is just theories and applications are left hanging. Since learners of today are proactive but not fully guided with the things to be inculcated for them to apply their learnings to address environmental problems. Thus, a challenge to this must be upheld, a challenge that will make sense in developing active learners to engage in community-based projects which are innovative.

Challenge-Based Learning is an approach for learners to focus on identifying challenges and implementing thoughtful and sustainable solutions to communities. In this approach, learners are first educated on the environmental problems, identify problems through ocular inspection about their individual communities, and propose and innovate possible solutions. This approach serves as a guide for learners to become actively engage themselves in solving community problems with their creativity and critical thinking skills.

The research teachers who were experts on the field will spearhead and guide the learners in coming with novel outputs. They will be indulged in various series of activities from planning, modelling, application and reflection to ensure effectiveness of their outputs. They will also be assessed in their creativity and the critical thinking skills they've shown as they explore the world of innovative research.

This study is relevant and timely to recently so-called community-based problems for it allow learners to develop novel outputs through their creativity and critical thinking skills and passion to source out innovative research projects. Today's generation needs builders and innovators to answer the call of the nation that in the school setting, science teachers should guide their learners to become scientifically passionate in becoming catalysts of environmental solutions.

Research Questions

This study primarily aims to investigate the effect of Challenge-Based Learning Approach in developing students' creativity and critical thinking skills in Practical Research. Specifically, this study sought to answer the following questions:

1. What are the students' research projects and its community-based contributions?
2. Is there a significant difference between experimental and control group's evaluation in terms of:
 - a. creative ability;
 - b. scientific thought;
 - c. thoroughness; and
 - d. skill?
3. How does challenge-based learning approach in research hone students' creativity, in innovating novel community-based research projects?

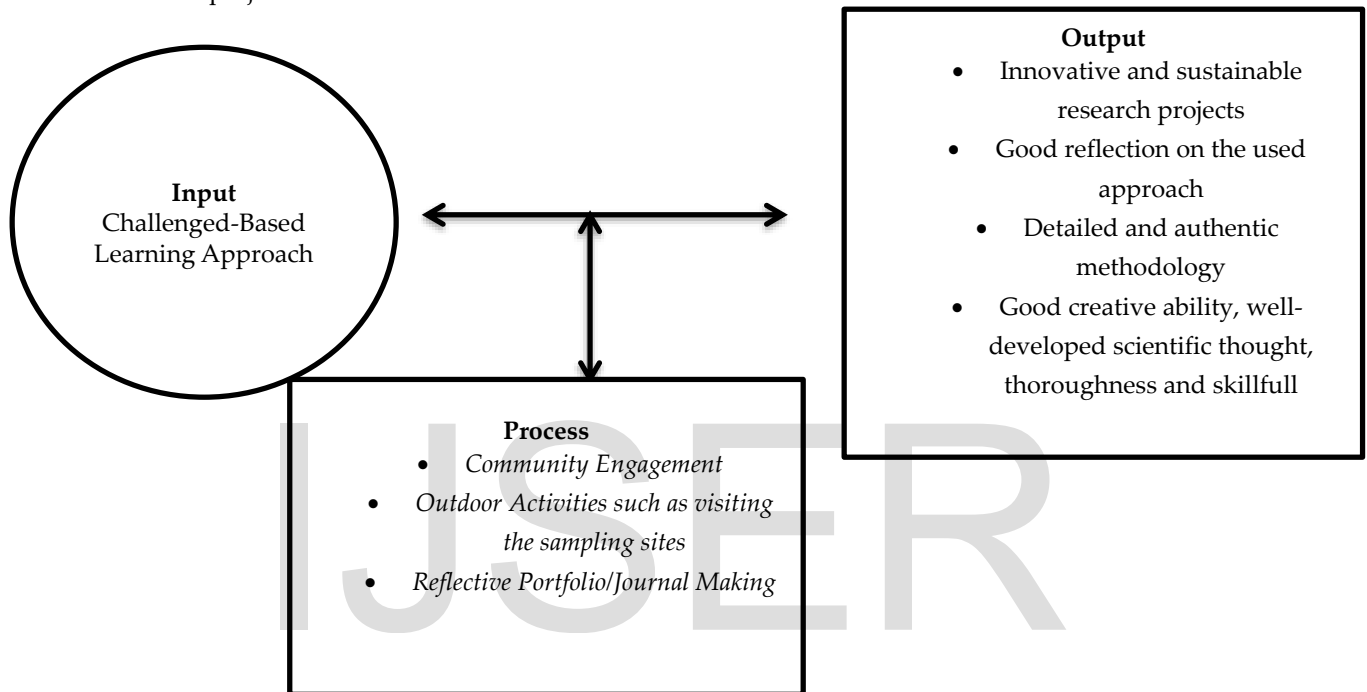


Figure 1: Framework

Method

A. Respondents and/or other sources of Data and Information

This action research will focus on Grade 12-Science, Technology, Engineering and Mathematics (STEM) students of the Misamis Occidental National High School, School Year 2019-2020. A total 72 (n=72) respondents will be taken and will be divided into two groups; experimental (G_1) and control (G_0). The researchers will make sure that both groups are homogeneous as they group them which mean they have the congruency of attitudes and responses towards their subject.

B. Research Instruments, Data Gathering Methods, and Analysis Plan

Research Instruments

Students' Reflection – Participants will be required to write a daily reflection based on the reflection guides provided by the researcher. A thematic analysis technique will be used in this instrument.

Research Project Evaluation Tool – the projects of the students will be evaluated as to their creative ability, scientific thought, thoroughness, and that was adapted from the Department of Education (DepED) Memorandum No. 113, s. 2019.

Data Gathering Methods

The study was conducted in a 10 week session beginning in the middle of June. Both groups were differently. The experimental group experienced the intervention which is the challenge-based approach while the control is the usual tradition in teaching research in science. Both the parents of the group were informed and were asked consent that their children were respondents of the study. Rest assured that if there will be positive results of the study, it will be adapted in the

Capstone/Research Project as the culminating activity of the STEM Strand. Results of the study were informed to the parents during the PTA meeting.

Project evaluation tool and journal were given to both groups to assess the output and reflection of the students in their journey in making the research project. Timeline of activities were presented to the students for them to be guided with the deadlines.

Analysis

The data collected in the study were analysed depending on the type of data collected. The research projects of the students in both two groups were evaluated to its applicability and sustainability to solve community-based problems. A panel of experts were tasked to evaluate the projects given the project evaluated form adapted from the Department of Education for evaluating the Science Investigatory Projects for the National Science and Technology Fair. Mean scores of the team were tabulated and analysed in relation to their reflection on their journal. A t-test was used to determine the significant difference of the two groups in terms of the creative ability, scientific thought, thoroughness and skill of the respondents.

This action research will utilize experimental and control group design. The proposed intervention will be administered for eight weeks in both two classes.

Table 1: Schematic Diagram of the Research Study

Experimental Group		Control Group
Intervention	X	O
Assessment	Students' Creativity in designing community-based projects	Students' Creativity designing community-based projects

Where:

X = Intervention (Challenge-Based Learning Approach)

O = Traditional Approach

Both qualitative and quantitative data will be obtained using different assessment tools. For quantitative data, students' creativity and critical thinking skills will be assessed through the use of questionnaires and checklists. For qualitative data, reflections of the students will be administered at the end of the intervention.

Results

Table 2: Themes and uses of the research outputs for the control group

Research Outputs	Themes	Uses
1. Malunggay and Papaya Peels natural coagulant	Green Environment	For water purification
2. RH ash Hollow Blocks	Green Environment	For alternative use of sand
3. Bioplastic from sweet potatoes	Green Environment	To reduce water pollution
4. Plastic as plywood additive	Green Environment	To reduce plastics
5. Styrobricks	Green Environment	To reduce long decomposing materials
6. Sugar paste	Green Environment	For alternative source of sugar

Table 3: Themes and uses of the research outputs for the experimental group

Research Outputs	Themes	Uses
1. Bristol paper from peanut wastes	Green Environment	For alternative use of paper

2. Bioplastic from animal wastes	Green Environment	For reducing plastics which are too long to decompose
3. Bioplastic from fruit wastes	Green Environment	For reducing plastics which are too long to decompose
4. Hydropower generator	Green Environment	To look for alternative source of electricity among remote areas
5. Noise absorbing board	Green Environment	To reduce noise pollution
6. Biofilter from Banana parts	Green Environment	To reduce air pollutants

Table 4: Average comparison of creative ability, scientific thought, thoroughness and skill between the experimental and control group

Dependent Variable	Group	Students (n)	Mean	Sig.	Comparison	Remarks
Creative Ability	Experimental	36	25.84	0.000	Experimental > control	Significant
	Control	36	22.63			
Scientific Thought	Experimental	36	26.04	0.001	Experimental > control	Significant
	Control	36	23.42			
Thoroughness	Experimental	36	18.54	0.001	Experimental > control	Significant
	Control	36	17.13			
Skill	Experimental	36	18.67	0.002	Experimental > control	Significant
	Control	36	17.29			

* $\alpha=0.005$

A. How does the approach in your Practical Research 2 hone your creativity in innovating novel community-based research projects?

Theme 1. Challenging Activities

P1. "The pressure set made the journey very challenging but fun at the same time...heheheheh..I encountered numerous challenges but with the help of my excellent mentor, I was able to surpass it."

P2. "Although research is not new to me, Practical Research 2 was really a whole new thing . it was not easy to accomplish but was made possible through hardwork and perseverance along the way with our teacher's guidance."

Theme 2. Getting out of the comfort zone

P3. "Our teacher was really pushing us through our limits especially on time management and critical thinking in a holistic perspective."

P4. "...I don't know with the kind of approach that my teacher did.. but one thing for sure was that it was an extraordinary experience having the one-semester research. Although we lack time but we really get out in our comfort zone and think critically in order to solve solution with the community....it's hard...but fulfilling..."

Theme 3. Meaningful Activities

P5. "I really don't know why for this semester, I feel like research for me is a lucrative activity. It is because I enjoy and my community soon would benefit from it..... I felt like I'm a scientist. I really like the activities set by our teacher it is like we are true when we engage ourselves in a community by looking problems and accepting the challenge as we think out of the box."

Discussions

Table 2 shows the themes and uses of the research outputs for the control group. As stated, all of the research outputs of the students pertain to environmental issues in which they look for possible solutions in order to lessen environmental problems

as evident to the uses stated. Like for example shown above which is the issue on plastics and styrofoams, alternative solution to this are the use plastics as an additive to plywood and styrobriks (styrofoam and bricks) which could all lessen wastes which difficult to decompose. However, in the journey of the researchers they encountered difficulty in making the paper and the product itself. With the interpolation of the panel experts, researchers admitted some problems regarding their research outputs like the sustainability issues and the right methodology applied. When students were engaged in an environment where they are properly guided with things to do and challenges set on, they will be enlightened with such measures to innovate things in order to look for possible set-up in mitigating problems. This is in accordance with the study of Johnson et al. (2009) when they let students engage in challenges the students were positive in doing hard work and persistent to find solutions to solve the challenge set.

The table 3 also shows the themes and uses of the research outputs of the experimental group. All of the research outputs of the students are of positive contributions to the community and promote green environment. In the context of the local here in Oroquieta City which is the ordinance on the use of plastics, research studies for bioplastics and bristol papers are timely and relevant. For noise and air pollutions, studies of noise absorbing board and biofilter are of great contributions for these. In the context, since Oroquieta City is progressing as to its establishments like resto bars and vehicles, these would be useful. This is consistent with Vong and Kaewurai (2017), that when students were properly managed and engaged in desired learning activities, their critical thinking skills and creativity are developed as challenged imposed and ability to think creatively and find solutions to a community problem could be their priority.

Table 4 shows the remarks of the average comparison of creative ability, scientific thought, thoroughness and skill between the experimental and control group. As shown, all of the means of the experimental groups are greater than the control group. All of the values for significance in all the dependent variables are less than 0.005 (Natural Human Behavior, 2017) which entails that there are significant differences among the two groups given the different dependent variables. Aims of the challenge-based learning approach develop creative ability, scientific thought, thoroughness and skill of the students as they engage in research inquiries. When they exposed to an environment where challenge is there, they will think creatively through applying scientific thought and motivated to finish the project with the desired skills. This proves the study of Changwong et al. (2018), in their study on learning management model which allow students in the experimental group to perform better in their critical thinking skills and achievement scores.

For both control and experimental group, clear differences were shown in their processing the paper together with their output. As the research teacher encountered their difficulties, automatically both the research teacher and the consultant guided them of their mistakes to make things possible. In the control group, from the introduction to conclusions and recommendations, evidently, most of the researchers were encountered difficulty in constructing contextualized introduction, coherent questions, systematic methodology, substantive discussions and right conclusions. While in the experimental group, as shown in the output, contextualization is evident since in the introduction most of them really want that their barangay will benefit in their study. They really had the systematic methodology as they consciously adapted methods from the literatures and properly cite them. In results and discussions, most of the discussions were substantive and results are in accordance with the order of the research questions. Both the group were able to come up with the recommendations.

Stated in all answers of the respondents in the experimental group are all positive in such a way it picture out how the approach help them realized their full potentials as researchers someday. They have different perceptions and experiences encountered as they indulge themselves in their community by looking problems and try solving it. This is true according to the study of Johnson et al. (2009) about further increasing their interest in the process and giving them valuable experience in team dynamics and collaborative work.

Summary of findings

Based on the results, the following summaries have drawn:

1. Both the experimental and control groups were able to design and innovate research projects.
2. For experimental group, clear and detailed methodology is evident on their research projects.
3. All of the research projects of the experimental group are locally useful in the community and promotes green environment.
4. All of the dependent variables like creative ability, scientific thought, thoroughness and skill are significantly different among the two groups.
5. There is a significant difference between experimental and control groups evaluation of creative ability, scientific thought, thoroughness and skill.
6. Of the participants interviewed, all of them were positive on their experiences with the given approach which is Challenge-Based Learning.

Conclusions

With the given findings, the following conclusions are drawn:

1. Respondents in both control and experimental groups are time conscious and responsible in meeting deadlines to make research projects.
2. Respondents in the experimental group are into details and able to grasp the approach delivered by the teacher.
3. Challenge-based learning approach intervened in experimental group is effective in gearing the students to innovate research projects which are contextually relevant, detailed and sustainable.
4. Challenge-based learning approach is effective in developing the learners' creative ability, scientific thought, thoroughness and skill in innovating research projects.
5. Respondents are positive on their behaviour towards the approach used by the teacher in facilitating learning in Practical Research 2.

Recommendations

Based on the findings, the following recommendations were drawn:

1. correlate the results of the research projects with the academic achievement of the respondents;
2. educate the community with the uses of the research projects invented; and
3. collaborate with the Department of Science and Technology, Technology Application Promotion Institute and the Department of Trade and Industry for mass production, intellectual property enrolment and market value.

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