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Project Based Learning in the Technical and Vocational Education and Training

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ABSTRACT

Organic Agriculture is a significant research topic of Sustainable Agriculture and a key factor in ensuring the conservation of the natural environment and preservation of life. Numerous studies on Didactics have demonstrated the effectiveness of student centered methods and strategies to improve results in terms of knowledge, skills, attitudes and values in Technical and Vocational Education and Training (TVET). This position paper explored how to improve the professional education of skilled workers and technicians in order to solve their diversity of professional problems with the aid of a Project Based Learning (PBL) approach. The proposed solution was implemented in a suburban Technical and Vocational School (TVS) with the Second Year Agronomy students and it is a solution based on the Cuban educational context. This paper provided some key issues regarding PBL pedagogy and an example of Organic Agriculture Project which would help Agricultural Science teachers as a guide in the process of planning new projects.

Keywords: organic agriculture, project based learning, sustainable agriculture

INTRODUCTION

The development of new generations demands TVET institutions to create a competent, adaptable an innovative workforce, contributing to sustainable development. Learning in the XXI Century should ensure students to have not only knowledge and skills but the ability to meet complex demands by drawing on and mobilizing physiological resources to solve professional problems in a particular context as well.

How are learning activities taking place in the TVET institutions?

The results of the baseline and diagnose assessments, lesson observations and the teaching experience of the authors revel different insufficiencies in the initial education of Cuban skilled workers and technicians such as:

- Teachers frequently present the subject content fragmentally and decontextualized of real life situations.
- Teachers abuse of using traditional problems which are not enough to favor the development of skills to solve opened situations and real life problems.
- Occasionally, problems are solved and the field of application is not taken into consideration.
- During lessons, teachers do not pay attention to real life applications.

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These insufficiencies of teachers negatively impact on students because of:

- Students solve problems mechanically.
- Students are no able to solve real life problems.

This situation shows a contradiction between the demand of preparing a competent workforce of Cuban skilled workers and technicians and the preparation of TVET teachers in which these insufficiencies were observed.

That is why, the following problem is identified: How to improve the professional education of skilled workers and technicians to solve the diversity of professional problems?

PROJECT BASED LEARNING

This article looks at the above mentioned problem trough of the lenses of the PBL pedagogy. It assumes that education provides students' deeper engagement with learning and school trough active exploration of real world problems and challenges which can only be addressed with interdisciplinary approaches.

The article shows TVET teachers some key issues regarding PBL pedagogy and an example of PBL implementation based on the Cuban educational context.

A literature review showed that the roots of PBL are in the progressive educational movement which promoted more student involvement and engagement (Peterson, 2012). It is recognized that William Heard Kilpatrick developed the ¨Project Method¨ inspired by the philosophy of John Dewey.

However, evidence have been found that the concept of learning trough projects was develop in the XVII and XVIII Centuries (Knoll, 1997).

How is PBL defined?

A bibliographic research on this topic showed that PBL is seen indistinctively as a pedagogy, a pedagogical approach, an active style of learning, a type of inquiry-based learning and a method.

For example, the free encyclopedia Wikipedia defines PBL as 'a student-centered pedagogy that involves a dynamic classroom approach in which it is believed that students acquire a deeper knowledge through active exploration of real-world challenges and problems. Students learn about a subject by working for an extended period of time to investigate and respond to a complex question, challenge, or problem. It is a style of active learning and inquiry-based learning'. (Wikipedia, 2018).

Stephanie Bell defines PBL as "a student-driven, teacher-facilitated approach to learning because of students pursue knowledge by asking questions that have attracted their natural curiosity" (Bell, 2010, p. 39).

On the other hand, "PBL is considered to be a particular type of inquiry-based learning where the context of learning is provided through authentic questions and problems within real-world practices". (Al-Balushi & Al-Aamri, 2014).

In order to achieve the objective of this article, the definition of PBL as a method is assumed.

As stated by (Knoll, 1997, p. 59) "The project is one of the standard teaching methods. It is generally considered a mean by which students can (a) develop independence and responsibility, and (b) practice social and democratic modes of behavior".

"PBL is a teaching method in which students gain knowledge and skills by working for an extended period of time to investigate and respond to an authentic, engaging, and complex question, problem, or challenge." (What is PBL?, 2018).

A PBL is student driven, (Bell, 2010), that is why it usually begins with a driving question or real life problem which leads to the creation of an artifact (model, design, device, computer program, arts, etc.) by mean of completion a variety of tasks. The socialization of the project is critical and it is done in a written and oral way, summarizing the procedure used to produce the product and presenting the outcomes.

The following benefits of PBL can be mentioned:

- Provides integrated understanding of the concepts and knowledge.
- Develops practical and research skills.
- Facilitates collaborative learning and team work.

- Facilitates interdisciplinary work (connections across different subjects).
- Provides stronger and more relevant preparation.
- Improves learner engagement in school.
- Strengthens learner motivation and interest.
- Makes learning experiences more relevant and meaningful.
- Allows teachers to assign projects for students with a diverse variety of interests, motivations, intelligences, learning styles, abilities, career aspiration and personal backgrounds.

What must a project have in order to be considered PBL?

These are (Thomas, 2000) design principles of PBL.

1. Centrality: PBL are designed considering the core curriculum elements.
2. Driving Question: PBL are focused on real life questions and problems which catch student attention and "drive" students to propose solutions considering the central concepts and principles of a discipline.
3. Constructive Investigations: PBL involves students in a constructive investigation, in this way, students are familiarized with the scientific method and current scientist activities.
4. Autonomy: PBL are student driven and the teacher play the role of facilitator or mentor.
5. Realism: PBL are not simple learning activities to be covered during a lesson. It looks at real world challenges.

Consistent with (Tellez Lazo, 2005), to implement PBL as a teaching method different phases need to be considered.

First phase: Identification of the problem or driving question. The problem can never be imposed by the teacher. The students are free to choose the problem to be investigated but it must be in accordance with the core curriculum elements and the needs of the school and the company in which it will be implemented.

Second phase: Analysis of human and materials resources. It is important to analyze the availability of material resources to complete the project as well as the class in terms of diversity (Intelligences, learning styles and economic, educational and cultural backgrounds).

Third Phase: Design of action plan. These actions are planned from theory and practical point of views. PBL is a student driven that is why the teacher serves as a facilitator during this phase.

Fourth Phase: Execution of designed actions. This is the longest phase. Here in this phase, individual and group work take places. The students socialize the results in collaborative ways. As the objectives of the project are achieved, professional and research skills are developed.

Fifth Phase: Presentation of results. Students write and present the results. This is important to develop language skills.

Sixth Phase: Project evaluation. A variety of assessment methods are used such as self-assessment, peer assessment and group assessment. Not only the results are assessed but also the whole process and development of skills, values and attitudes. These phases can be summarized as shown in **Figure 1**.

Now, an example of PBL based on the Cuban educational context is shown.

AGRICULTURAL SCIENCE EXAMPLE

Project Overview

It is recommended to start with an overview of the project and explaining some ideas that justify the need of the research work in order to find the solution of the identified problem. As shown in this example, a deductive procedure was used. The overview began from the most general expression of the problem (The World Food Crisis) to specific (The Community of Manatí).

The world food crisis is a problem that affects many countries and it is seen as one of the worst calamities in the planet. According to the World Food Programme (WFP), currently there are approximately 124 million people in 51 countries are currently facing Crisis food insecurity or worse. Every second one person dies due to hunger or because of causes related with the starvation in the World (UN, 2018).

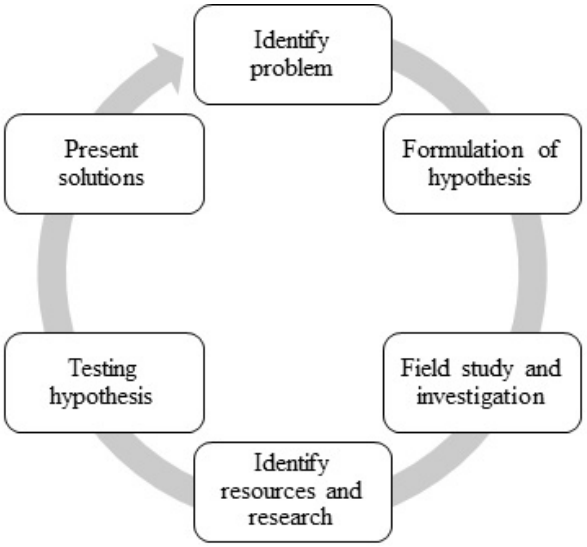

Figure 1. Project Based Learning Cycle

Causes of this serious problem, among others things, are poverty, climate change, natural disasters, military conflicts, poverty, misuse of the environment and lack of agricultural infrastructure.

Manatí is a coastal municipality on the north coast of Las Tunas province. Last century, large area of forest was cleared due to timber industry, coal production and sugar cane industry imposed by colonizer and American corporations.

These aggressive agricultural practices left a situation in which:

- The soils of its principal town are mostly saline as well as affected by erosion.
- Coastal area is affected by the impact of tropical storms and hurricanes.
- Short raining season and large dried season.

In Manatí, there is a farm in which some sustainable agricultural practices are needed to increase the fertility of the soil. That is why the following driving question or problem was identified.

Driving Question/Problem

How to improve the fertility of a saline soil seriously affected by erosion, implementing sustainable agricultural practices?

This project will provide students that are interested in sustainable agriculture with the foundational concepts for the future sequence of courses in soil and plant science, organic agriculture, direct marketing, crop production and farm business operations.

Hypothesis

The compost is a product that is obtained of compounds that form or are part of living matter of animal or vegetable origin. It constitutes a great resource of decomposition of organic matter, which is used to obtain the humus.

The demand for organic products creates new export opportunities. Organic exports are sold at impressive prices 20% higher than the same products produced on non-organic farms. The market from organic agriculture can potentially contribute to local food security and improve family's incomes.

Thus the following hypothesis is stated:

If organic agricultural practices are used, the fertility and productivity of the saline soils seriously affected by erosion would be improved.

General Objective

Upon completion of this project, students should be able to develop an agriculture system that incorporates key ecological principles and sustainable management practices.

Specific Objectives

- Identify the key principles of sustainable agriculture and ecology.
- Describe several different models of sustainable agriculture systems.
- Execute techniques to obtain organic compost.
- Apply organic compost to improve the quality of the soil.
- Conserve the soil using organic compounds.
- Develop a culture of producers and an environmental awareness.
- Identify potential career and marketing opportunities in sustainable agriculture.

Group Project Requirements

To organized the group work, we proposed the following requirements:

1. Groups of no more than four will be formed to complete the group portion of the project.
2. Each member of the group will have a given responsibility.
3. In case of a group with less than four members, each member may have more than one responsibility.
4. The roles are as follows:

Project Leader: This member gets information to absent students, meets deadlines, fills in for absent members, coordinates the efforts of the entire group, ensures that members understand the material.

Engineer: Main design ideas would come from this person; she/he works with the leader in assigning the various components to be made by the other members of the group.

Treasurer: This member develops the budget, ensures group stays on budget, keeps financial records, builds components as assigned.

Speaker/Communicator: This is the person who write the report and present the results of the project.

Content Topics Addressed

This project facilitates interdisciplinary work. Contents of different subject were discussed and used. For example:

Agronomy

- Soil fertility and nutrient management.
- Chemical analysis of the soil and water.
- Maintenance of soil fertility and productivity.
- Integrated nutrient management.

Organic Agriculture

- Conversion to organic agriculture.
- Water, nutrient, pest and disease management in organic agriculture.
- Crop planning in organic agriculture.

Chemistry

- Organic chemistry.
- Types of reactions.
- Endothermal and Exothermal reactions.

Mathematics

- Calculation of areas and volumes.
- Statistics.

Physics

- Hydrodynamic.

- Measurements and Measuring instruments.
- Work, energy and power.

Biology

- Microorganisms.
- Bacteria.
- Fungus.
- Decay.
- Conservation.

Materials and Resources

- Farm.
- Manure bovine.
- Remains harvest.
- Water.
- One inch metallic tubes.
- Wheelbarrow.
- Rake.
- Shovel.
- Machete.
- Thermometer.

Time Line

The project was completed in nine months, an academic year. The first and second weeks were dedicated to soil diagnose and a literature review on sustainable agricultural management. The third and fourth weeks were dedicated to collect and transport the composting materials and montage of the piles. From the second up to the fourth month, the students prepare the compost and assess the stage of decomposition during the heating, cooling and maturing phases. The fifth month, the humus was harvested and applied to improve the quality of the soil. From the seventh up to the ninth month, the students evaluated the results. The presentation of results was held at the end of the ninth month.

CONCLUSIONS

Benefits

Upon completion of the project the following benefits can be summarized. The project:

- Increased the fertility and productivity of the soil by means of sustainable agricultural practices.
- Promoted an environmental and producer awareness at a School and Community level.
- Provided integrated understanding of the concepts and knowledge on sustainable agriculture.
- Developed practical and research skills, values and attitudes.
- Facilitated interdisciplinary work (connections across different subjects).
- Improved student motivation.
- Made learning experiences more relevant and meaningful.
- Facilitated Placed Based Education, Inquiry Based Learning and Problem Based Learning.

Challenges

As every human activity, the project was no perfect and some challenges can also be summarized.

Table 1. General Rubric for Project written reports

Indicators	Levels of performance				
	Exemplary	**Proficient**	**Satisfactory**	**Below standard**	**Unsatisfactory**
Information sources	Used a variety of relevant sources (three or more different types and several of each type of source). Cited all sources.	Used many sources of two types. Cited all sources.	Used many sources of one type (e.g. textbooks, Internet, journals, magazines, questionnaire. Sources were referenced.	Two or three sources were used.	One source used and referenced.
Sources had data to support claims.	All sources (but one) had data to support claims.	Most sources had data to support claims.	Some sources had data to support claims.	One source had data to support claims.	No source had data to support claims.
Extracted relevant information.	All information extracted was relevant to the topic.	All information extracted was relevant to the topic. However, no information was given for one aspect.	Some relevant and some irrelevant information was extracted.	Little relevant information was extracted.	Little information was extracted; it was mainly irrelevant.
Paraphrased information.	All information extracted was paraphrased and well written.	Most information was paraphrased and well written.	Some information was paraphrased. However, copied portions were not indicated.	Most information was copied from sources.	All information was copied from sources.
Organized information.	Information was very clearly and sequentially organized. The position was logically stated with supporting data. Alternative points of view were included.	Information is clearly and sequentially organized. Logically stated position with supporting data.	Information was clearly and sequentially organized.	Information was sequentially organized.	Information was written haphazardly.
Synthesized	Project clearly and articulately showed: problem, hypothesis, method of research, literature reviewed, findings, analysis of findings, position.	Project showed: problem, hypothesis, method of research, literature reviewed, findings, analysis of findings, position.	Project showed problem, hypothesis, method of research, literature reviewed, findings, analysis of findings, position (one missing).	Project showed problem, hypothesis, method of research, findings.	Notes shown on aspects of the project.
Language	Write clearly and distinctly throughout the report, does not have writing errors.	Write clearly and distinctly throughout the report, have no more than two writing errors.	Write clearly and distinctly for most of the report, makes no more than two grammatical and writing errors.	Misuse key vocabulary, have more than two grammatical and writing errors.	Misuse key vocabulary, have more than ten grammatical and writing errors.
Grade	A 86 – 100	B 71 – 85	C 56 – 70	D 41 – 55	F 40 and lower

- Some farmers refused to share experiences on sustainable agricultural development and soil conservation.
- The students faced some concerns since they have to learn outside of school (field and home) with adults who are not trained educators.

General Rubric for Project Written Reports

A rubric with seven indicators and different levels of performance is proposed to evaluate the project written report and is shown in **Table 1**.

General Rubric for Oral Presentations of Projects

A rubric with seven indicators and different levels of performance is proposed to evaluate the oral presentation of projects in **Table 2**.

Table 2. General Rubric for oral presentation of projects

Indicators	Levels of performance				
	Exemplary	**Proficient**	**Satisfactory**	**Below standard**	**Unsatisfactory**
Preparedness	Completely prepared.	Seemed well prepared but could have spent more time rehearsing.	Somewhat prepared, but seems not to have rehearsed.	Did not seem prepared to present.	Appeared to have made no effort to prepare.
Time/length	Duration was for the required time.	Duration was longer or shorter than the time allotted by 0 – 20% of duration.	Duration was longer or shorter than the time allotted by 21 – 30% of duration.	Duration was longer or shorter than the time allotted by 31 – 40% of duration.	Duration was longer or shorter than the time allotted by 41 – 67% of duration.
Enthusiasm	Facial expressions and body language evoked a strong interest in and enthusiasm from the audience.	Facial expressions and body language sometimes evoked a strong interest in and enthusiasm from the audience.	Facial expressions and body language were used to spark interest and enthusiasm from the audience but the expressions seemed faked.	Very little use of facial expressions and body language. Did not evoke interest or enthusiasm from the audience.	Little enthusiasm was shown by the presenter(s).
Content – information	Included the necessary information which was correct and current.	Included the necessary information which was correct.	Information included was correct. However, it included necessary as well as some unnecessary information.	Less than 50% of the required information was included.	Insufficient information was given, some of which was incorrect.
Language	Speaks clearly and distinctly throughout the presentation, does not mispronounce words.	Speaks clearly and distinctly throughout the presentation, mispronounced one and two words.	Speaks clearly and distinctly for most of the presentation, mispronounces key vocabulary or makes one or two grammatical errors.	Mumbles at one or two points, more than two grammatical errors.	Mumbles most of the presentation, mispronunciation and grammatical errors.
Effectiveness in making a point.	Song etc. was very effective in marketing its message.	Song etc. made a point strongly.	Song etc. made a point related to the topic.	Information in the song etc. was disjointed.	Lyrics did not portray a theme.
Creativity	A very high level of creativity shown.	A good standard of creativity shown.	Some creativity shown.	Creativity shown.	Little or no evidence of creativity is shown.
Grade	A 86 – 100	B 71 – 85	C 56 – 70	D 41 – 55	F 40 and lower

Project Evaluation Questionnaire for Teachers

Dear teachers!

This questionnaire is a survey evaluating projects as part of the institutional self-evaluation of "Gregorio Careaga Medina" Technical and Vocational Education School. The survey provides you an opportunity to evaluate the projects you were involved in the previous academic year. You are kindly requested to give your opinion trough filling in the questionnaire provided.

The questions and items are shown in **Table 3** and **4**.

Table 3. Question 1

Question #1 Below are a series of statements. Please respond by circling the number you feel most reflects your opinion.

Items	Strongly agree	Agree	Uncertain	Disagree	Strongly disagree
Indicator 1: Project Content and Organization					
1.					
2. The project objectives were clear.	5	4	3	2	1
3. The project workload was manageable.	5	4	3	2	1
4. The project was well organized (e.g. timely access to materials, notification of changes, etc.)	5	4	3	2	1
Indicator 2: Student Contribution					
5. Student attendance was good during the whole project.	5	4	3	2	1
6. Students participated actively in the project.	5	4	3	2	1
7. Students behavior was appropriate during the whole project.	5	4	3	2	1
Indicator 3: Learning Environment					
8. The learning environment encouraged participation.	5	4	3	2	1
9. The learning environment was conducive to learning.	5	4	3	2	1
10. The learning environment was conducive to researching.	5	4	3	2	1
Indicator 4: Materials and Resources					
11. The availability of materials and resources was appropriate.	5	4	3	2	1
12. Learning materials and resources were relevant and useful.	5	4	3	2	1
13. The provision of learning resources on the Web was adequate and appropriate.	5	4	3	2	1
Indicator 5: Assessment					
14. The methods of assessment were reasonable.	5	4	3	2	1
15. Feedback on assessment was timely.	5	4	3	2	1
16. Feedback on assessment was helpful.	5	4	3	2	1

Table 4. Question 2

Question #2: Indicate the level of achievement during the project.

Items	Excellent	Very good	Good	Fair	Poor
Indicator 6: Knowledge					
1. Mathematics, Science, Humanities and professional disciplines.	5	4	3	2	1
2. Problem formulation and solving skills.	5	4	3	2	1
3. Collecting and analyzing appropriate data.	5	4	3	2	1
4. Ability to link theory to practice.	5	4	3	2	1
5. Computer knowledge.	5	4	3	2	1
Indicator 7: Communications Skills					
6. Oral communication.	5	4	3	2	1
7. Report writing.	5	4	3	2	1
8. Presentation skills.	5	4	3	2	1
Indicator 8: Interpersonal Skills					
9. Ability to work in teams.	5	4	3	2	1
10. Leadership.	5	4	3	2	1
11. Independent thinking.	5	4	3	2	1
12. Motivation.	5	4	3	2	1
13. Reliability.	5	4	3	2	1
14. Appreciation of ethical values.	5	4	3	2	1
Indicator 9: Work skills					
15. Time management skills.	5	4	3	2	1
16. Judgment.	5	4	3	2	1
17. Discipline	5	4	3	2	1

Thank you for the time to answer all the questions.

CONCLUSIONS

As a conclusion, this position paper showed that organic agriculture is a significant topic in the field of sustainable development. It also showed TVET teachers some key issues regarding PBL pedagogy and an example of Agricultural Project based on the Cuban educational context which ensure students to acquire not only the knowledge but also the skills, the ability to meet complex demands by drawing on and mobilizing physiological resources to solve professional problems in a particular context with an interdisciplinary perspective. The example increased students motivation, participation and engagement and at the same time it contributed to a deep and meaningful learning.

Disclosure statement

No potential conflict of interest was reported by the authors.

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