Project Based Learning for STEM (Science, Technology, Engineering, Mathematics) Education

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1. Abstract:

Project-based learning (PBL) for STEM Education is an interesting and effective way to learn about science, technology and mathematics. It is a technique used in making concepts understand for completing a goal with greater knowledge. The main purpose of PBL is to learn the activities by implementing them. Project-based learning is an approach emphasizing on teaching students by engaging them in investigation of the particular task and making them learn things by practically implementing it. In this way students get significant solutions to complex problems by asking and refining questions, sharing and debating ideas, experimenting and predicting solutions, gathering data and analyzing in teams, drawing conclusions, building leadership qualities, suggesting new proposals and broader methodologies to implement, creating artifacts. This approach will incorporate students with all the professional values needed for their successful career and make them technically flexible of facing any challenges with ease and with great effectiveness. The main aim of PBL is making students enjoy what they do which helps them remember about the lecture for greater depth, builds confidence to face any problem with ease, makes students learnt to work collectively in teams and build collaboration within their peers, makes students follow systematic approach of recognizing and solving a problem, builds competition within themselves for better results. This method brings great help for teachers as well to monitor every work what student does and guide them accordingly to complete their task with good effect ensuring students build their career with strong foundation.
2. Introduction

A project in contemporary world is defined as organized way to achieve a goal. In order to achieve an aim with effectiveness a project needs to have careful planning or proposal, scope, cost incurred, time desired for completion.

In this advanced world where students are engaged to learn many things it is becoming difficult for them to remember about the lectures they hear in class. As the days pass, in vain of learning new things students forget about the lectures taught by the teacher in class a week before. There are two reasons for it 1. No practice about the lecture learnt, 2. No time to implement the lectures learnt practically. This has become a huge concern for teachers, parents, students and the society. Then arise the question how can we make students remember about the lectures they learnt for long time? Is it possible for them to incorporate lessons to greater depth in this fast pacing world? Then the concept called Project Based learning was introduced giving solutions to all this questions. They strongly believe just by watching soccer in television we cannot become a good soccer player it is more important to practice and practically involve in playing the game in order to become a good player. This approach allows students to learn simultaneously by implementing them. In this way it gives student understand the lecture better, since they are doing practically they can any time approach the teacher for doubts during their project. They start taking responsibilities and focus on learning in an enjoyable and effective manner. This approach helps students know what they are doing, what is the need of doing, what is the goal and design the best effective solution. This phenomenon also helps teachers to contact students easily and know their progress better by seeing the work students accomplish in completing every module and task. It is also easy for them to clear the doubts of the students and make them understand concepts with great effect.
3. **Advantages of BPL**

How PBL helps in effective learning for Students?

- By the outcome of their recent developments and results many researchers have confirmed that Project-Based learning is the best and most enjoyable way to learn.
- In this way a Student will actively engage themselves towards a project and incorporates lessons with interest.
- PBL helps a student to think and analyze about a task in a broader and effective way.
- In this way students will not only get greater depth of knowledge on a subject but also build collaboration within their mates to achieve a goal.
- PBL helps students in taking responsible tasks at their own and solve problems with confidence.
- Since teachers and other expects are also the members of the project it provides greater flexibility of utilizing there advertise and skills for the students.
- Students tend to propose new and different innovations to make their project more creative.
- PBL allows teacher to closely monitor the students work and help them to achieve their task with high quality.
- PBL helps the student to build leadership qualities and learn how to manage things.
- Project Based Learning technique helps students relatively to enter into problem.
solving learning journey.

4. How to follow PBL approach?

4.1 Introducing about PBL

Initially teacher gives an overview to students what a Project Based learning is about. For what we are using PBL and make students familiarize about this approach. Teacher has to assign a project to students and guide them through out ensuring students are able to understand the concepts completely. Teacher has to make students understand all the protocols and the procedure needed to follow in order to develop their projects with best effect. Teacher will also mention their role in the project and explain students about their participation in completing the given project in time.

4.2 Problem Overview

Next phase is to explain students about the task assigned to them. Teacher has to explain students about the problem, what are their responsibilities and their roles in accomplishing the task. It is the responsibility of teacher to make students understand the problem and create interest in solving them by illustrating with examples.

For example: Task is to build a ship

Teacher has to explain student about the ship and its advantages, about the procedure involved in building the ship, about various factors to consider while progressing the work, various precautionary measures while building a ship, risks involved, and the benefits students get by building this ship.

4.3 Analyzing steps for efficient solution

Teacher has to explain students about the steps to be followed before starting the project for efficient solution. This step is very important because it involves the constructive
methods of how to solve a problem. This approach should be very interactive by allowing students to express their views and strategies in achieving their goal with efficiency.

From the above example:

After teacher giving complete synopsis about their projects Students can express their various views by which they can achieve his/her aim. Every student has different methods of build the ship depending on the department they are put into. They can freely communicate their various ideas to the teacher about their task and analyze the best approach to complete the task.

4.4 Estimating Cost and Time incurred for completing the task:

Teachers will explain students about various materials and equipment’s required for completing the task. Depending on the materials required students along with their mentor should start estimating a desired cost that has to be put in for completing the task and time that is needed in completion of the project. The cost and time go in logger heads the more number of days needed for completing the project the more cost we invest.

From the above example:

After analyzing how to proceed further with building the ship. Teacher should explain students about the materials required in building ship and the use of every material used n building. In common for building a paper ship we require bunch of paper sheets, scissors, glue, work book, weighing machine to measure the weight of the ship according to its platform and to measure kinetic energy inside the ship. Students need to estimate the cost for these materials and the time by which they can complete building a ship by using the required material. Students need to take permissions from the teacher for the cost and time invested for the correct advice.

4.5 Designing of the problem:

In this step students will start implementing the plan to achieve their goal. According to the various steps designed earlier according to their responsibilities they start working on
the modules assigned to them. Teacher will keep monitoring every students work and guide them accordingly ensuring every student will learn maximum knowledge during the project work.

In case a student has a different design to follow in order to achieve his goal at any time he should be free to communicate with the teacher and discuss why he is planning to change the plan which was implanted before.

From the above example:
Depending on their departments students will start building a ship. They start with the structural part one they measure the kinetic energy and weight the ship can withstand. Basing on these measure the student start building a ship bearing in mind to accomplish the project with success and uniqueness. In this way it builds competition within their peers and every student starts enjoying the work they do in learning about their project how to build a ship.

4.6 Submitting the solution
After completing the project students will submit their respective projects to the teacher for grades. It is easy for the teacher to judge the grade basing on the outcome of the project and how unique the project is being developed. In this way right from the childhood every student starts thinking differently and try to complete their task in a professional manner with maintaining quality.

4.7 Additional Innovations
The problem solving learning teaching will immensely help students to think beyond what is already existing and express their new ideas they found out during developing there project. In this way student will never forget what he/she has learnt during developing the project and also creates an interest in student for future implementing advanced features for the project which is developed already by them.

5 Advantages to the students:
- Intense learning on the subject
• Builds systematical approach in solving a problem
• Builds confidence on how to solve a problem with ease
• Self- learning
• Self- thinking
• Self- analyzing
• Building responsibilities in solving a problem
• Collectively working with the peers
• Builds Leadership qualities
• Competition within the peers
• New idea for innovations

6 Examples

Example 1

<table>
<thead>
<tr>
<th>IDEA</th>
<th>Building a Ship</th>
</tr>
</thead>
<tbody>
<tr>
<td>Objectives</td>
<td>Students are placed in different departments to work on their assigned tasks</td>
</tr>
<tr>
<td>Responsible Tasks</td>
<td>Students have to calculate the Weight, draft and kinetic energy of the ship</td>
</tr>
<tr>
<td>Learning skills</td>
<td>Students learn about the components of a ship, operations within a shipyard, methods of ship construction, design calculations</td>
</tr>
<tr>
<td>Material Requirements</td>
<td>Teacher’s manual, Student handout, student book, scissors, rulers, glue sticks, protractors and tape.</td>
</tr>
</tbody>
</table>
Example 2

<table>
<thead>
<tr>
<th>IDEA</th>
<th>Construct a Submarine</th>
</tr>
</thead>
<tbody>
<tr>
<td>Objectives</td>
<td>Students with enact as employees of PQR yard</td>
</tr>
<tr>
<td>Responsible tasks</td>
<td>Identify the number of parts required in building a submarine, construction of a submarine and cost of a ship</td>
</tr>
<tr>
<td>Learning skills</td>
<td>Students will learn basics about ship, about submarines and the construction methodologies, How to estimate the cost and how to measure the required number of parts</td>
</tr>
<tr>
<td>Material Requirements</td>
<td>Teacher’s manual, students handout, students book, cost estimator, ruler</td>
</tr>
</tbody>
</table>

Example 3

<table>
<thead>
<tr>
<th>IDEA</th>
<th>Identifying possible causes for disasters</th>
</tr>
</thead>
<tbody>
<tr>
<td>Objectives</td>
<td>Students should be able to estimate the possible causes for disaster and the immediate preventive measures of safeguarding the ship</td>
</tr>
<tr>
<td>Responsible Tasks</td>
<td>Students have to imagine as Disaster agencies and analyze what are the factors that cause disasters. Should model the design of the ship in such a way it can overcome the disasters</td>
</tr>
<tr>
<td><strong>Learning skills</strong></td>
<td>Students learn about the fundamental components of the ship. Importance of a strong design and preventive methods for a ship.</td>
</tr>
<tr>
<td>---------------------</td>
<td>-----------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td><strong>Material Requirements</strong></td>
<td>Teacher’s manual, Student handout, student book, Disaster agency manual.</td>
</tr>
</tbody>
</table>

Example 4

<table>
<thead>
<tr>
<th><strong>IDEA</strong></th>
<th>To build an Sea perch robot</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Objectives</strong></td>
<td>Students should be able to understand the underwater robotics program and ocean engineering principles</td>
</tr>
<tr>
<td><strong>Responsible Tasks</strong></td>
<td>Students need to build an underwater Remotely Operated Vehicle (ROV) which engineers all the operations done inside the sea.</td>
</tr>
<tr>
<td>Learning skills</td>
<td>Students learn about the fundamentals of Robotics, underwater functionalities, resources and live beneath the sea.</td>
</tr>
<tr>
<td>---------------------------------------</td>
<td>---------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Material Requirements</td>
<td>Teacher’s manual, Student handout, student book, scissors, glue, Artificial Intelligence material for building the robot.</td>
</tr>
</tbody>
</table>

7 Conclusion

In this paper we have presented how Problem based learning is an effective approach to make students like and enjoy what they are learning. In traditional way students listen to the lecture and practice later without much guidance and participation from the teacher. But by using problem solving learning method student and teachers will actively participate and ensures that the project is developed with intense care and focus. Students share their knowledge with their peers and make them understand the course what they are learning. There will not be any
chance for the student to escape from learning the course as they are under continuous supervision of the teacher. Students will learn their work efficiently as they have to submit every work they put in for developing the module assigned to them. This approach builds professionalism in the student’s right from childhood and ensure they have right strategies to achieve their goal.

8 Reference

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• http://www.seaperch.org/what_is