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Project-Based Learning on Learning Mathematics

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Abstract

Curriculum 2013 with more emphasis on character education, especially at the primary level, which will be the foundation for the next level. In practice, Curriculum 2013 must be implemented through activity-based learning-based integrative scientific approach and thematic. To encourage the students' ability to generate contextual work, either individually or in groups then it is advisable to use approaches that produce work-based learning problem solving (Project Based Learning). Through the learning model students are expected to have an attitude of competence, knowledge and skills are much better. So that students will be more creative, innovative, and more productive in accordance with the objectives of the Curriculum 2013. For the realization of the implementation of Curriculum 2013 that standard quality, effective, efficient, and relevant, as well as a significant contributory and graduates for life in the future, then the existence of such approaches, models and strategies in the learning process carried out in accordance with the demands of the curriculum is required. One of the learning model is recommended for use by teachers associated with the implementation of the 2013 curriculum is project-based learning model. Through project-based learning model and the problem-based learning is expected to assist students in constructing their own knowledge of the concept with the experiences of previously owned. The lack of research in Indonesia related to the implementation of project-based learning model to be used as a reference for teachers in applying learning in accordance with the curriculum in 2013 became one of the motivations for researchers to examine the application of the learning model. Project-Based Learning is a learning model that uses a project or activity as a medium. Students conduct exploration, assessment, interpretation, and synthesis of information to produce various forms of learning outcomes. Project-based learning is a learning model that uses contextual issues as a first step in collecting and integrating new knowledge based on their experiences in real activity. Project-based learning is designed to be used in complex learning required students to investigate and understand. Project-based learning (PjBL) is one of the most effective ways available to engage students with their learning content, and for that reason, PjBL is now recommended by many educational leaders as a best instructional practice.

Keywords: Project-Based Learning, Learning Mathematics

Advocates for project-based learning report that they frequently encounteran array of conflicting responses to their call for this approach to learningand teaching. They report hearing that “we already do that” and “we can’t dothat because we don’t have the time (or space or expertise or resources, etc.).”People doing project-like work will say they don’t do projects and othersdoing work that seems hardly project-like at all may call what they doproject-based.

In interpreting this report, Karen Pittman, Executive Director of The Forum for Youth Investment, sees youth development and educational practices coming together. In the face of major economic shifts that put a premium on educational experience and credentials, youth development researchers and practitioners are increasingly concerned about expanding learning opportunities and showing the impact of informal learning on academic as well as developmental outcomes. At the same time, many educators are deeply concerned about young people’s lack of motivation in connection to school. This

is leading to a convergence on learning as a goal and on defining and creating richer opportunities for learning both inside and outside of school.

Some Goals for Learning Through Projects

Drawing from the perspectives of children, adults, and learning theorists, it is possible to construct some ambitious, but reasonable, goals for children's learning through projects in after-school:

- ✓ To link fun and playfulness with serious work and learning, often with a community service aspect to the effort.
- ✓ To provide a natural social context for learning by bringing children into relatively small working groups within which they must pool knowledge and theories to achieve the group's goals. It is in these groups that students can think aloud and learn next to and through other's ways of learning and solving problems.
- ✓ To provide students with experiences in which literacy and numeracy are essential elements and are integrated into meaningful efforts to figure things out, make things, and solve problems. (These experiences are not meant as a substitute for all other approaches to teaching those who aren't literate how to read, yet they can still be critically important for contextualizing reading as an essential and valuable skill.)
- ✓ To help students build an image of themselves as capable of learning what they want and need to learn, doing and achieving things they never thought possible, and working in libraries, on the web, and with others to accomplish complex tasks. These are lessons critical to becoming a successful life-long learner and a productive contributor to one's community (whether at work, at home, in one's neighborhood, or in broader communities).
- ✓ To provide students with opportunities for experimentation, selfcorrection, and, most importantly, reflection on not just "what" they are learning, but on "how" they learn.

Characteristics of work that is LESS project-like:

1. Entirely teacher-initiated
2. Very short term; incorporates few steps; essentially teacher-designed
3. Modest assessment and reflection
4. Few, if any, connections to the community

Characteristics of work that is MORE project-like:

1. Teacher/student negotiated with initiation by teachers
2. Moderate length; multiple steps; evolving process
3. Sequenced, but with numerous points of choice for students
4. Community resources brought in
5. An end-of-project assessment of quality and learning

Characteristics of work that is MOST project-like:

1. Teacher/student negotiated with initiation by students
2. Students and teachers plan and carry out sequence with all choices anddecisions made by group

3. Project can take as long as it needs; evolves over time with group makingdecisions about process
4. Many community resources brought in; and the group reaches out to the communityboth for help and to provide service/presentation performance
5. Assessment is on-going and final/summative; focused on quality and substance of learning, of individuals and group; conducted by teacher and students as individuals and as a group

Project-based Learning (PjBL) is a model for classroom activity that shifts away from the usual classroom practices of short, isolated, teacher-centred lessons. PJBL learning activities are long-term, interdisciplinary, student-centred, and integrated with real-world issues and practices. It is a method that fosters abstract, intellectual tasks to explore complex issues. It promotes understanding, which is true knowledge. In PJBL, students explore, make judgments, interpret, and synthesise information in meaningful ways. It is more representative of how adults are asked to learn and demonstrate knowledge.

Project-based Learning approach is an "in-depth investigation of a real-world topic worthy of children's attention and effort." Hence, fi eld trips, experiments, model building, posters, and the creation of multimedia presentations are sample activities within PJBL where students with differing learning styles demonstrate their knowledge by means of inquiry.

In sum, PjBL should:

• Be anchored in core curriculum and multidisciplinary
• Involve students in sustained effort over time
• Involve students in decision-making
• Be collaborative
• Have a clear real-world connections
• Use systematic assessment: both along the wayand end product

Why Is Project-Based Learning Important?

1. Project-based Learning and the use of technologybring a new relevance to the learning at hand.

By bringing real-life context and technology to the curriculum through a Project-based Learning approach, students are encouraged to become independent workers, critical thinkers, and lifelong learners. If students learn to take responsibility for their own learning, they will develop in the way to work with others in their adult life. Project-based Learning is not just a way of learning, but a way of working together. Besides students, teachers can communicate with administrators, exchange ideas withother teachers and subject-area experts, and communicate with parents, all the while breaking down invisible barriers such as isolation of the classroom, fear of embarking on an unfamiliar process, and lack of assurances of success.

2. Project-based Learning lends itself to authentic assessment.

Authentic assessment and evaluation allows systematic documentation of a child's progress and development. Project-based Learning lets the teacher have multipleassessment opportunities. It allows a child to demonstrate his/her capabilities while working independently. Project basedLearning also develops the child's ability to workwith his/her peers as well as building teamwork andgroup skills. A teacher learns more about the child as aperson. It helps the teacher communicate in progressiveand meaningful ways with the child or a group of childrenon a range of issues.

3. Project-based Learning promotes lifelong learning.

Lee Shulman, president of the Carnegie Foundation forthe Advancement of Teaching stated, "Teaching has beenan activity undertaken behind closed doors betweenmoderately consenting participants." Project-basedLearning and the use of technology enable students,teachers, and administrators to reach out beyond theschool building. Students become engaged builders of anew knowledge base and become active, lifelong learnersthus taking control of their learning. In that pursuit ofnew knowledge, technology allows students' access toresearch and experts, from such sources as fi rst personaccounts to movies of the Civil War found on the Libraryof Congress' "American Memory" collection to online chatswith NASA astronauts.

4. Project-based Learning accommodates students withvarying learning styles and differences.

Children having different learning styles, build theirknowledge on varying backgrounds and experiences.It is also recognised that children have a broader rangeof capabilities than they have been permitted to showin regular classrooms with the traditional text-basedfocus. Project-based Learning addresses these differencesbecause students must use all modalities in the process ofresearching and solving a problem, then communicatingthe solutions. When children are interested in what theyare doing and able to use their areas of strength, theyachieve at a higher level.

How to Implement Project-Based Learning?

Real PjBL, by contrast, is deep, complex, rigorous, andintegrated where each stakeholder in the school plays animportant role. In implementing PJBL, its fundamentalsare fourfold:

- Create teams of three or more students to workon an in-depth project for three to eight weeks.
- Introduce a complex entry question thatestablishes a student's need to know, and scaffoldthe project with activities and new informationthat deepens the work.benchmarks, and fi nally the team's presentationto an outside panel of

experts drawn from parentsand the community.literacy.projects for content, oral and writtencommunication, teamwork, critical thinking, andother important skills.

Step 1. Start with the Essential Question

The question that will launch a Project-based Learninglesson must be one that will engage students. It is greaterthan the task at hand. It is open-ended. It will pose aproblem or a situation that the students can tackleknowing that there is no ONE answer or solution.

Step 2. Design a Plan for the Project

When designing the project, it is essential to selectcontent standards to be addressed. Involve students inthe planning process. Students feel ownership of theproject when they have an active role in deciding activities.Base on the curriculum, select activities that support thequestion. Know what materials and resources to be madeaccessible to students. Be prepared to delve deeper intonew topics and issues as students become more involvedin pursuit of answers.

Step 3. Create a Schedule

Design a timeline for project components. Realise thatchanges to the schedule will happen. Be flexible, but helpstudents realise that a time will come when they need tofi nalise their thoughts, fi ndings, and evaluations. Allowstudents to go in new directions. Guide them when theyappear to be going in a direction that has no connectionto the project. Help students to stay on course but don’taccidentally set limitations.

Step 4. Monitor Students and Project Progress

Facilitate the process and inculcate love for learning.Teach students how to work collaboratively. Designatefluid roles for group members. Let students choose theirprimary roles but assume responsibility and interactivityfor other group roles. Remind students that every partof the process belongs to them and needs their totalinvolvement. Provide resources, guidance and assess theprocess through creating team rubrics and project rubrics.Team rubrics state the expectations of each team memberwhile project rubrics refer to evaluation requirements ofthe projects. As such, these requirements must be madeclear to students to ensure success in their projects.

Step 5. Assess the Outcome

Assessment provides diagnostic feedback and helpseducators set standards. It allows one to evaluate progressand to relate that progress to others. It gives studentsfeedback on how well they understand the informationand what they need to improve on. Assessment also helpsteachers design instruction to teach more effectively.Whenever

possible, allow self-assessment among students.If student's and teacher's assessment contradicts, astudent-teacher conference to justify learning outcomesshould be held.

Step 6. Evaluate the Experience

In the busy schedule of a school day, there is often littletime for reflection. Yet, reflection is a very important partof the learning process. Set a time for reflection of dailyactivities. Allow individual reflection, such as journaling,as well as group reflection and discussion. Share feelingsand experiences, and discuss what worked well and whatneeds change. Share ideas that will lead to new questions,thus new projects.

The three keys to successful projects: exhibition, multiple drafts, critique

Key 1: Exhibition

When students know that the work they are creating in a project willbe displayed publicly, this changes the nature of the project from themoment they start working – because they know they will need to literally'stand by' their work, under scrutiny and questioning from family, friends,
and total strangers.This inspires a level of ambition and commitment much greater than is fuelledby the incentive of 'getting good marks'. In addition, students' families, aswell as other people from the local community, get to see what is going on inthe school, providing an opportunity to strengthen the relationship betweenthe school and community.

Key 2: Multiple drafts

The case for giving students time to make multiple drafts of their work is hard to refute – the trouble is that it's difficult to make time for more than one draft, which is one reason why it is so important to produce a realistic project timeline when you are designing your project. Multiple drafts are also valuable for personalising assessment, because they provide you with the means to assess, not only a student's final product, but also the extent to which they have improved their work since the first draft. This can be valuable for all students, but it is particularly helpful for students with special educational needs, and students for whom English is not a first language.

Key 3: Critique

Getting into the habit of creating multiple drafts of work has a huge impact on how students regard their assignments, their learning, and themselves. It is especially effective when students are critiquing each other's drafts, rather than just handing in drafts to a teacher. Formal critique sessions give students the opportunity to learn from each other's work and from each other's feedback in a structured, safe context – this can include critique of the process ('how I made this thing') as well as product ('the thing I

made'). Critique sessions can become lessons in theirown right, because they provide the opportunity for teachers to introduce concepts and skills at a point when students will be eager to learn them. Equally importantly, they bring students' misconceptions about the project to the surface, so that the group can respond to them.

Examples of the application of PjBL in the learning of mathematics

Make Cookies for a Class Bake Sale
Name of Project : Make Cookies for a Class Bake Sale
Project Objectives
When students complete this project, they will be able to:
1. Understand and follow the directions in baking cookies
2. Bake cookies using the right measurement tools and baking equipment
3. Work together as a group to accomplish the desired goal
4. Use technology to design a print advertisement for the bake sale
5. Organize and interpret data of sold items by using a tally chart
6. Write a journal about their experience in baking and selling the cookies

Integration of Other Functional/Academic Skills
In completing the task, the students will be able to make use of skills in other subjects: mathematics, language arts and technology.

Subjects	Activities	Objectives
Mathematics	Use math skills to choose and use the appropriate tools in measuring, read the clock, and interpret data in a chart as necessary in completing the project	Students record data by using tallychart. Students interpret data in a tally chart. Students tell time.
Language Arts	Understand and follow directions, compose a simple advertisement, and write a journal about the project	Students give, restate, and followtwo-step directions. Students use context to resolveambiguities about word and sentencemeanings. Students write brief narrativesdescribing an experience. Students apply and follow basiccapitalization and punctuation rules inwriting their narratives
Technology	Use the computer in designing a print advertisement for the project.	Students locate, identify and use somebasic word processing terms, such as file open, menu bar, save, print. Students locate and use keys

		inentering letters, number, and specialsymbols on the keyboard. Students explore internet resources todownload clip arts and photos usingteacher-created bookmarks.

Activities

Day	Activities	Material	Duration	Procedure
1	Designing a PrintAdvertiseme nt and a Tally Chart for the Bake ale	Computers Printers **Venue:** Classroom	1hour	Present to the class a sample of anadvertisement for a bake sale. Inform them about the necessarycontents in it, such as the time,place, items sold. Let the studentsread aloud the items found in theadvertisement. Ask the students the purpose of atally chart. Inform them that theyare to create one to organize andinterpret the different kinds ofcookies sold in the bake sale. Show the students the programs orapplications that they may use indesigning the print advertisementand making the tally chart. Presentthe websites where they candownload photos or clip arts toenhance their work. Divide the class into groups of four(this will be their permanentgroup). Give them enough time toconceptualize and develop theirprint advertisement and make thetally chart. Evaluate their works before havingthem printed. Peer evaluating maybe done, or the teacher alone maydo this.
2	Baking of the cookies	Measuring cup and spoon Cookie	1 hour	Write on the board a simplified version of the procedure in bakingthe cookies. Guide the students asthey read aloud teach

		sheet Baking tray Cookie mix Oven **Venue:** Kitchen		step. Ask thestudents if there are terms they findconfusing, and unlock difficulties ifnecessary. Present to the students themeasuring cup and spoons to beused. Familiarize them with thenumbers found in each tool, andmodel how they are used byshowing sample measurement foringredients (such as water or flour). Divide the class into groups of fourand observe them as they go aboutthe procedure. Preheat the ovens. (Students arenot to touch hot surfaces on theoven.) Afterwards, place the cookietrays inside, and instruct thestudents to be aware of the timewhen the cookies are done. Gather the cookies once they arewell-done. Let them cool beforestoring them in containers, inpreparation for the bake sale thenext day.
3	Bake sale	Cookies in trays Print advertiseme nts Tables and chairs Tally chart **Venue:** Cafeteria	30’	Prepare the group's booth, and putup the advertisement. A bell will berung to signal the beginning of thebake sale. Assign two members from thegroup to tally the cookies sold(there are two types of cookies ineach booth). The other twomembers are in charge of servingthe cookies ordered, and inreceiving and giving the change foreach payment.
4	Evaluation of the Activity	Tally chart Notebook Writing materials **Venue:** Classroom	1 hour	Present to the class the list ofactivities to be done for the day: Interpreting the data in the tally Presenting an oral report about the result of their group’s sales, with reference to the tally chart Let the students join their groups.A facilitator may be chosen to present to the group their tallychart.

				They must interpret the datagathered by studying the items inthe chart. These guide questionsmay be used: *Which type of cookiewas sold more? Which type ofcookie was sold less? What is youranalysis about the result of yoursales? Would you consider yourgroup a success in the bake sale?* *Why or why not?* One reporter foreach group will be tasked to shareto the class their group's evaluationof their sales. Grade each group based on rubricsfor each item (print advertisement,the cookies, oral report). Ask the students to write anarrative about their experience incompleting the project. They willbe given an individual grade fortheir journal.

Adapted from Ali Mahmudi (2011)

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