

PBL

Project Based Learning

by Ken Bos



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Special Thank You

And a cast of thousands...

*My wife, my kids, my instructors, my principals, my classmates,
my fellow staff members, my students,*

Muriel Bos

Elle Bos

Mandy Arthur

Andrew Arthur

Beth Marcus

Jane Orr

Donna Sederlund

Benji Dudek

Joni Clarke

Dave Johnson

Ralph Hansen

Donna Kay Gilman

Jamy Marske

Kristen Parker

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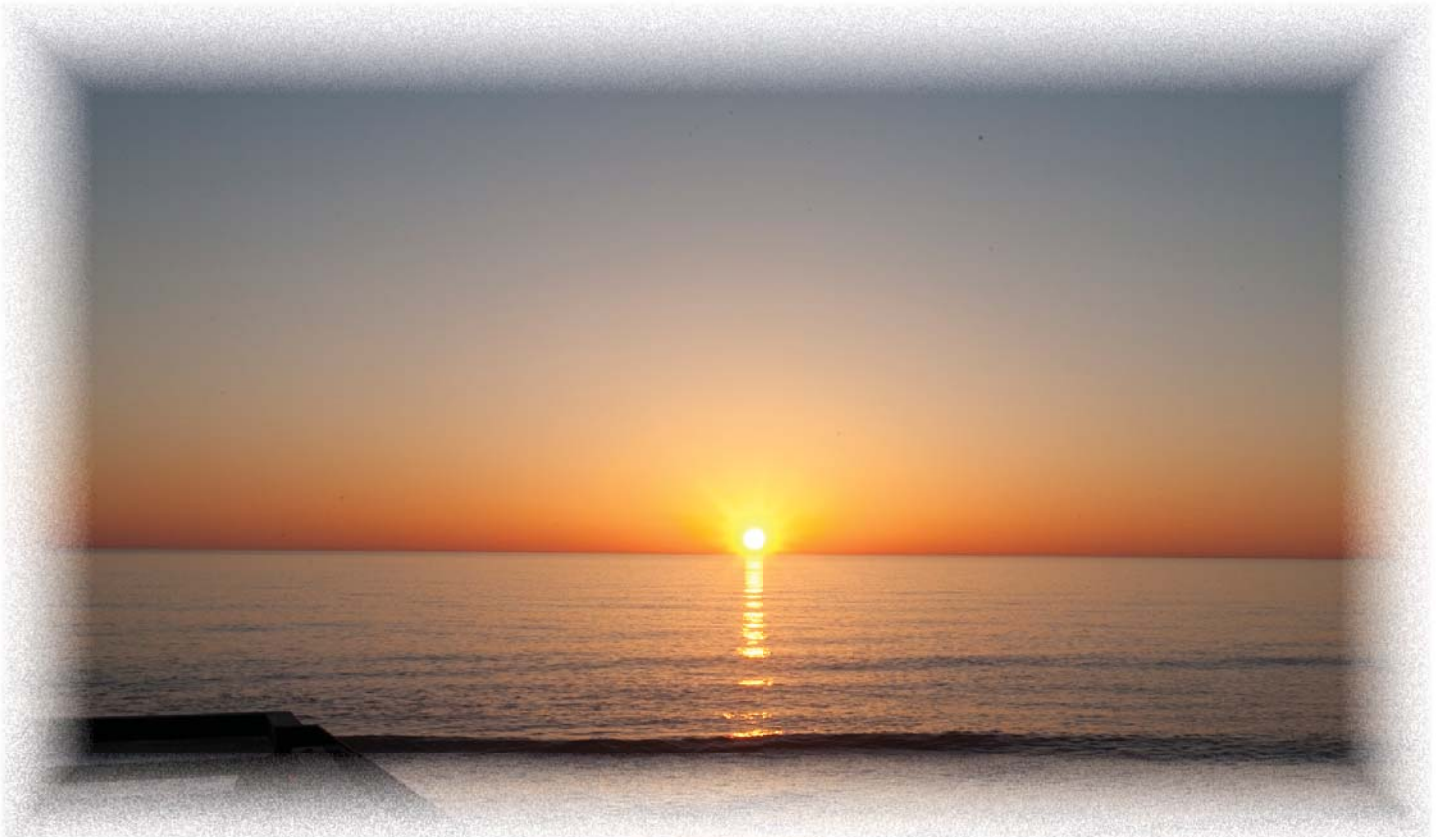
Amanda Bahmer

Anthony Earl Walker

Jeff Bogardus...

Topic Area

Project Based Learning - My goal was to improve the implementation of Project Based Learning (PBL). Although some subjects would have a difficult time using project based learning, it has evolved as the best way by far for my current teaching assignment. When I first used PBL I found that it seemed to work well with most students. As I gained expertise in PBL it worked even better. Students seem to enjoy being part of a project and they also seem to retain their knowledge when they can relate it to being part of a project. Students look back at an earlier guided project to help remember how they did something. Some projects require a lot of guidance while other projects allow for students to “find their own way” as they would in real life. There seems to be room for everyone to maximize their learning potential in PBL.



Rationale/Purpose

The purpose behind this study is to set a higher goal for learning in my assigned curricular area. Raising the students higher level thinking skill is our building goal this year. It is comprised of several components. My initial impetus was to complete my Masters degree to attain a higher level of pay that I should have done years ago. Additionally I have a long time passion for Computers, Photography, and strong penchant for appropriate use of Data. I also wanted to integrate my study with my building School Improvement Plan. Lastly my curricular area really has no defined curriculum, this study gave framework to that void. I believe I have satisfied all of my purposes with this study.



Abstract

This abstract is supposed to be written when the study is completed. I don't know if the study will ever be completed. The more I find out, the more there seems to be to learn. I suppose I can say that one chapter of the book is completed at this point but there still remains many more chapters to go.

Over the past two years I have come a long way in using projects in my subject area. I have come to depend on Project Based Learning as my primary mode of teaching. There still remains much to improve, but I can say that I have made major progress as well. My view of projects has grown and matured vastly. My skills at getting students involved with projects has also grown. Part of my job has been to become familiar with several pieces of nontrivial software. This software has made several revisions over the recent past that I needed to adapt to and relearn. Change is constant. The software and hardware are expensive. I have been fortunate enough to have grant money to help finance the operation. Part of my time as a teacher is also invested in retaining this funding source. These funds are vital in keeping up with the latest technology. The jobs and skills for today's students - tomorrow's workers - lie within being able to use the latest technology. I can't believe some schools (including our own) are still teaching Office 2003 to high school students as current technology. Our rapidly changing world needs to be able to adapt rapidly to the needs of our future workforce. Education in general has been slow to change. Institutions are always dragging their feet as living in the past is part of the stability that keeps institutions functional. Schools in general find it difficult to meet the needs of the future. One of the inventors of the Apple computer, Steve Wozniak, went back to school after he became rich from his part in the Apple. He found that schools were somewhat behind and gave up in his quest for a degree. Bill Gates found wealth by forging his own way in the business world. He did not depend on rote skills he obtained in school, but he used the higher level thinking skills to become the richest man in the world. I hope I have given my students the opportunity to develop these higher level skills to amass their own fortunes and design their own futures.

II Developing Research Questions

Name: Ken Bos

Date: 2/11/2007 completely revised 12/20/2007 and again 1/14/2008

Topic: Project Based Learning

Essential Question:

What methods will be used to create and maintain a Project Based Learning system with focus on the student that fit my unique goals?

Related Questions:

- Can the students act mature enough and accept responsibility to make good choices?
- Can the district find recourses to fund quality web classes?
- How can Project Based Learning help me with Bond issues, human resources, supplies, hardware, software, or other funding avenues?
- What will a Project Based Learning do to help me with the complex structure that allows the placement of students into web classes?

Developing Learner Centered Goals

Essential Question:

How can Project Based Learning help me to help students find ways to use their web skills productively?

Professional Goals:

- Find methods to help students accept responsibility to make good choices.
- Use Project Based Learning to help me find methods acquire the resources to finance this operation.
- Use Project Based Learning to help me work with the guidance department in planning for student selection of web design courses.
- Use Project Based Learning to help me work with LCC on coordinating student learning of web design methodologies.
- Use Project Based Learning to help me find the ideal structure to fit web design into trimester scheduling process.
- Attend workshops, seminars, online learning opportunities.

Learner Centered Goals:

- The student will find places students can earn money doing design work with the skills learned?
- The student will act mature and responsible.
- The student will find directions to go for advancement.

Relationship to School Improvement

Our building school improvement goal is to raise higher level thinking by 10%. It is interesting to note that the school improvement committee that I was a part of needed to learn what higher level thinking was before we could consider how to improve it. A source we found related that most colleges thought their job was to raise the students higher level thinking but few colleges could actually define higher level thinking. Project Based Learning has many connections to higher level thinking. Now that I realize my goal is to induce this thinking I can make even greater gains in this area.



Professional Outcomes

- To become more proficient at using projects in my curriculum
- To be able to use data and information to perfect my teaching
- To be able to work with Professional Learning Communities
- To stay as current as possible with advancing technology
- To learn and use the latest professional software available

Learner Outcomes

1. Knowledge- Knowledge is defined as the remembering of previously learned material. This may involve the recall of a wide range of material, from specific facts to complete theories, but all that is required is the bringing to mind of the appropriate information. Knowledge represents the lowest level of learning outcomes in the cognitive domain.

Illustrative General Instructional Objectives Knows common terms. Knows specific facts. Knows methods and procedures. Knows basic concepts. Knows principles.

Illustrative Verbs for Stating Specific Learning Outcomes Defines, describes, identifies, labels, lists, matches, names, outlines, reproduces, selects, states.

2. Comprehension- Comprehension is defined as the ability to grasp the meaning of material. This may be shown by translating material from one form to another (words or numbers), by interpreting material (explaining or summarizing, and by estimating future trends (predicting consequences or effects). These learning outcomes go one step beyond simple remembering of material, and represent the lowest level of understanding.

Illustrative General Instructional Objectives Understands facts and principles. Interprets verbal material. Interprets charts and graphs. Translates verbal material to mathematical formulas. Estimates consequences implied in data. Justifies methods and procedures.

Illustrative Verbs for Stating Specific Learning Outcomes Converts, defends, distinguishes, estimates, explains, extends, generalizes, gives examples, infers, paraphrases, predicts, rewrites, summarizes.

3. Application- Application refers to the ability to use learned material in new and concrete situations. This may include the application of such things as rules, methods, concepts, principles, laws, and theories. Learning outcomes in this area require a higher level of understanding than those of comprehension.

Illustrative General Instructional Objectives Applies principles to new situations. Applies theories to practical situations. Solves mathematical problems. Constructs charts and graphs. Demonstrates correct usage of a procedure.

Illustrative Verbs for Stating Specific Learning Outcomes Changes, computes, demonstrates, discovers, manipulates, modifies, operates, predicts, prepares, produces, relates, shows, solves, uses.

4. Analysis- Analysis refers to the ability to break down material into its component parts so that its organizational structure may be understood. This may include the identification of the parts, analysis of the relationship between parts, and recognition of the organizational principles involved. Learning outcomes here present a higher intellectual level than comprehension and application because they require an understanding of both the content and structural form of the material.

Illustrative General Instructional Objectives Recognizes unstated assumptions. Recognizes logical fallacies in reasoning. Distinguishes between facts and inferences. Evaluates the relevancy of data. Analyses the organizational structure of a work (art, music, writing).

Illustrative Verbs for Stating Specific Learning Outcomes Breaks down diagrams, differentiates, discriminates, distinguishes, identifies, illustrates, infers, outlines, points out, relates, selects, separates, subdivides.

5. Synthesis- Synthesis refers to the ability to put parts together to form a new whole. This may involve the production of a unique communication (theme or speech), a plan of operations (research proposal), or a set of abstract relations (scheme for classifying information). Learning outcomes in this area stress creative behaviors, with major emphasis on the formulation of new patterns and structures.

Illustrative General Instructional Objectives Writes a well-organised theme. Gives a well-organised speech. Writes a creative short story (or poem). Proposes a plan for an experiment. Integrates learning from different areas into a plan for solving a problem. Formulates a new scheme for classifying objects (or events, or ideas).

Illustrative Verbs for Stating Specific Learning Outcomes Categorizes, combines, complies, composes, creates, devises, designs, explains, generates, modifies, organizes, plans, rearranges, reconstructs, relates, reorganizes, revises, rewrites, summarizes, tells, writes.

6. Evaluation- Evaluation is concerned with the ability to judge the value of material (statement, novel, poem, research report) for a given purpose. The judgements are to be based on definite criteria. These may be internal criteria (organization) or external criteria (relevance and purpose) and the student may determine the criteria or be given them. Learning outcomes in this area are highest in the cognitive hierarchy because they contain elements of all of the other categories, plus value judgements based on clearly defined criteria.

Illustrative General Instructional Objectives Judges the consistency of written material. Judges the adequacy with which conclusions are supported by data. Judges the value of a work (art, music, writing) by using internal criteria. Judges the value of a work (art, music, writing) by use of external standards.

Illustrative Verbs for Stating Specific Learning Outcomes Appraises, compares, concludes, contrasts, criticizes, describes, discriminates, explains, justifies, interprets, relates, summarizes, supports.

Bloom and David R. Krathwohl. *Taxonomy of Educational Objectives, Handbook 1: Cognitive Domain*. Benjamin S. Addison-Wesley Pub. Co. 1984. (An updated exposition of the 1956 model.)

Rubric

<p>4 Quality – PBL is a way of life</p>
<p>The teacher is enthusiastically involved in <i>Project Based Learning</i> and initiatives as much as possible. New opportunities are planned, encouraged and regularly put into practice. A variety of experiences are employed. New projects are continually incorporated. Some projects offer a lot of guidance while other projects have little guidance and maximal open ended opportunity. Honesty, trust, respect, and individual differences are valued. A wide variety of projects are employed to allow for individual interests and differences. The six A's are used to evaluate the projects - authenticity, academic rigor, applied learning, active exploration, adult relationships, assessment. Scaffolding is used to provide all students with positive experiences. The students will demonstrate higher level thinking. Students will engage in projects with enthusiasm.</p>
<p>3 Deepening – achieving a degree of mastery</p>
<p>The teacher is involved with a diverse range of individual or group opportunities including external sources. Continuous learning, improvement and evaluation is promoted and transferred into practice. Learning new methods of instruction is valued. Curriculum updating is a priority. Students gain in their maturity.</p>
<p>2 Developing - Building commitment</p>
<p>The teacher has some involvement with the community, short courses of professional development activities, minor involvement with curriculum. Needs are assessed. Out-of- class commitments are beginning. Students find some assignments fun.</p>
<p>1 Starting out - Acquiring information</p>
<p>The teacher has little involvement in PBL or continual professional development, or curriculum improvements. Assignments are based on tool usage rather than methods or outcomes. Low challenges are the norm. Students just do the assignments without actually engaging.</p>

Plan of Action For Action Research

Research Topic –

PBL – Project Based Learning

Plans for Implementation

I hope to implement my project based learning skills to the fullest extent when school starts in the fall. This method seems to work best for the web and graphics courses I currently teach. Things are currently in limbo as to my exact teaching assignment, so it is difficult to plan accordingly. If my assignment is math I will not be able to implement PBL in those classes. One class I am pretty certain to teach will be my web publishing class. This is going to require me to spend considerable time on Adobe InDesign, which I have not used at all.

A component of my plan will be to include learning styles student motivation. The students need to know themselves before they learn anything. What learning mode works best for each student? What motivates each student?

Artifacts I Plan to Use:

Student written essays
Surveys
Additional data as I uncover it.

Timeline

June/July – research PBL in the library using ERIC and Melcat. Write reflections, complete my hours. Learn InDesign. Layout and design my own publication/book.

August/September - begin to implement my action research plan. Collect any additional artifacts or data as is needed. Publish a book with Lulu/Kablam/Blurb and compare outputs.

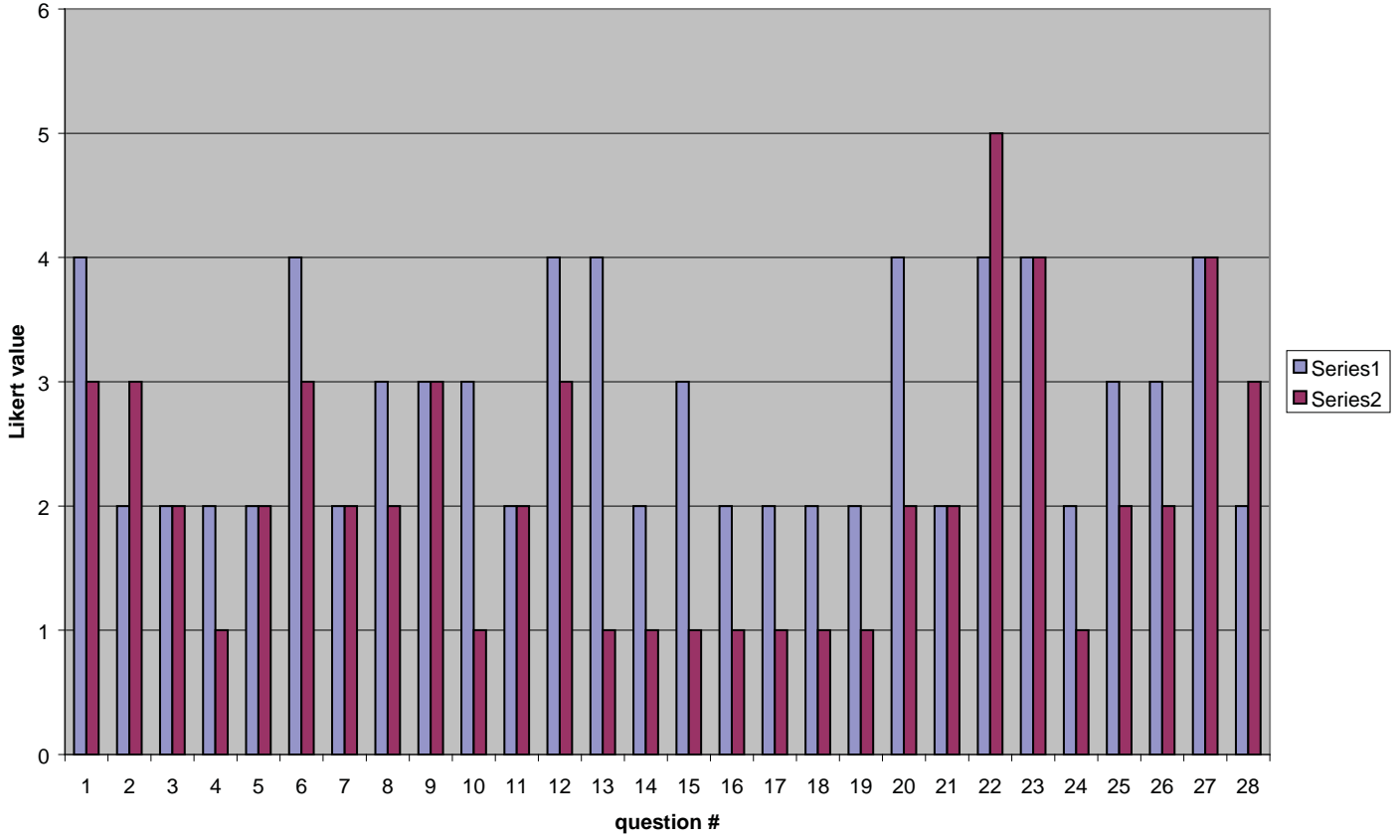
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QUESTIONNAIRE

Hour ___ Tri ___ Name _____

1. **I took this class because I am interested in the subject matter** ⇨⇨Strongly Agree • Agree • Neutral • Disagree • Strongly Disagree
2. **I took this class because it fit into my schedule** ⇨⇨Strongly Agree • Agree • Neutral • Disagree • Strongly Disagree
3. **I have learned about myself in this class** ⇨⇨Strongly Agree • Agree • Neutral • Disagree • Strongly Disagree
4. **I have learned to use software effectively in this class** ⇨⇨Strongly Agree • Agree • Neutral • Disagree • Strongly Disagree
5. **I have learned something useful in this class** ⇨⇨Strongly Agree • Agree • Neutral • Disagree • Strongly Disagree
6. **I have put in a lot of effort in this class** ⇨⇨Strongly Agree • Agree • Neutral • Disagree • Strongly Disagree
7. **This class is related to “real world” projects** ⇨⇨Strongly Agree • Agree • Neutral • Disagree • Strongly Disagree
8. **I have developed new skills in problem solving** ⇨⇨Strongly Agree • Agree • Neutral • Disagree • Strongly Disagree
9. **I have applied new knowledge in solving problems** ⇨⇨Strongly Agree • Agree • Neutral • Disagree • Strongly Disagree
10. **I have applied my knowledge in realistic problems**⇨⇨Strongly Agree • Agree • Neutral • Disagree • Strongly Disagree
11. **I have learned “self management” skills in this class** ⇨⇨Strongly Agree • Agree • Neutral • Disagree • Strongly Disagree
12. **I am interested in learning more of the subject matter** ⇨⇨Strongly Agree • Agree • Neutral • Disagree • Strongly Disagree
13. **This class is related to my future job possibilities** ⇨⇨Strongly Agree • Agree • Neutral • Disagree • Strongly Disagree
14. **I have received appropriate feedback about my work** ⇨⇨Strongly Agree • Agree • Neutral • Disagree • Strongly Disagree
15. **I see things differently after doing projects in this class** ⇨⇨Strongly Agree • Agree • Neutral • Disagree • Strongly Disagree
16. **I can distinguish good visuals from poor ones.....**⇨⇨Strongly Agree • Agree • Neutral • Disagree • Strongly Disagree
17. **I can create more effective visuals because of this class** ⇨⇨Strongly Agree • Agree • Neutral • Disagree • Strongly Disagree
18. **I can evaluate images better after taking this class** ⇨⇨Strongly Agree • Agree • Neutral • Disagree • Strongly Disagree
19. **I am proud of my work in this class.....**⇨⇨Strongly Agree • Agree • Neutral • Disagree • Strongly Disagree
20. **I like doing projects with instructions.....** ⇨⇨Strongly Agree • Agree • Neutral • Disagree • Strongly Disagree
21. **I like doing projects with few, or no instructions** ⇨⇨Strongly Agree • Agree • Neutral • Disagree • Strongly Disagree
22. **I would prefer more lecture in this class.....**⇨⇨Strongly Agree • Agree • Neutral • Disagree • Strongly Disagree
23. **I would prefer more group work in this class.....**⇨⇨Strongly Agree • Agree • Neutral • Disagree • Strongly Disagree
24. **I prefer to do individual work in this class.....** ⇨⇨Strongly Agree • Agree • Neutral • Disagree • Strongly Disagree
25. **I have learned “how to learn” in this class.....** ⇨⇨Strongly Agree • Agree • Neutral • Disagree • Strongly Disagree
26. **I learned how to make photos, not just take photos**⇨⇨Strongly Agree • Agree • Neutral • Disagree • Strongly Disagree
27. **This class is too hard.....**⇨⇨Strongly Agree • Agree • Neutral • Disagree • Strongly Disagree
28. **This class is too easy.....**⇨⇨Strongly Agree • Agree • Neutral • Disagree • Strongly Disagree

Questionnaire



The raw data on the right represents two semesters of using the Questionnaire and the mode of data. This data is represented graphically above in a chart form

#	mode1	mode2	Key
1	4	3	1 strongly agree
2	2	3	2 agree
3	2	2	3 neutral
4	2	1	4 disagree
5	2	2	5 strongly disagree
6	4	3	
7	2	2	
8	3	2	
9	3	3	
10	3	1	
11	2	2	
12	4	3	
13	4	1	
14	2	1	
15	3	1	
16	2	1	
17	2	1	
18	2	1	
19	2	1	
20	4	2	
21	2	2	
22	4	5	
23	4	4	
24	2	1	
25	3	2	
26	3	2	
27	4	4	
28	2	3	

VERBS THAT MAY BE USED IN STATING COGNITIVE OUTCOMES FOR DIFFERENT LEVELS OF REASONING

1. Knowledge: arrange, define, duplicate, label, list, memorize, name, order, recognize, relate, recall, repeat, reproduce state, record, identifies, matches, names, outlines

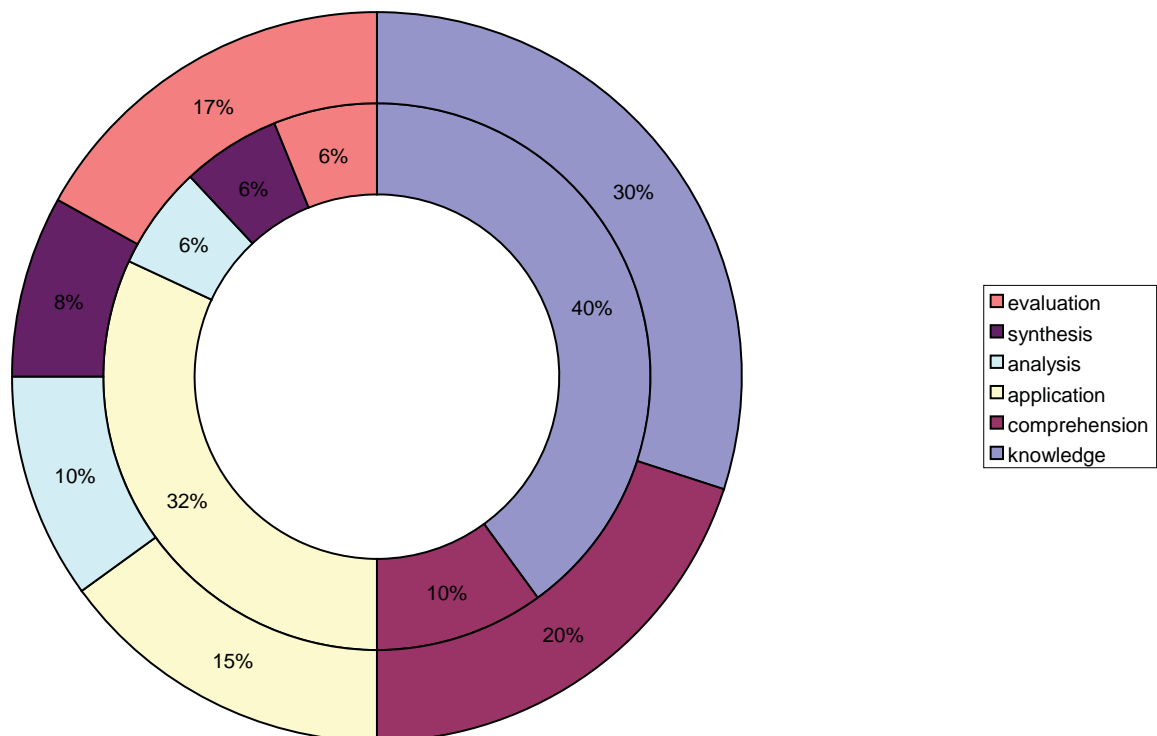
2. Comprehension: classify, describe, discuss, explain, express, identify, indicate, locate, recognize, report, restate, review, select, translate.

3. Application: apply, choose, demonstrate, dramatize, employ, illustrate, interpret, operate, practice, schedule, sketch, solve, use, write.

4. Analysis: analyze, appraise, calculate, categorize, compare, contrast, criticize, differentiate, discriminate, distinguish, examine, experiment, question, test.

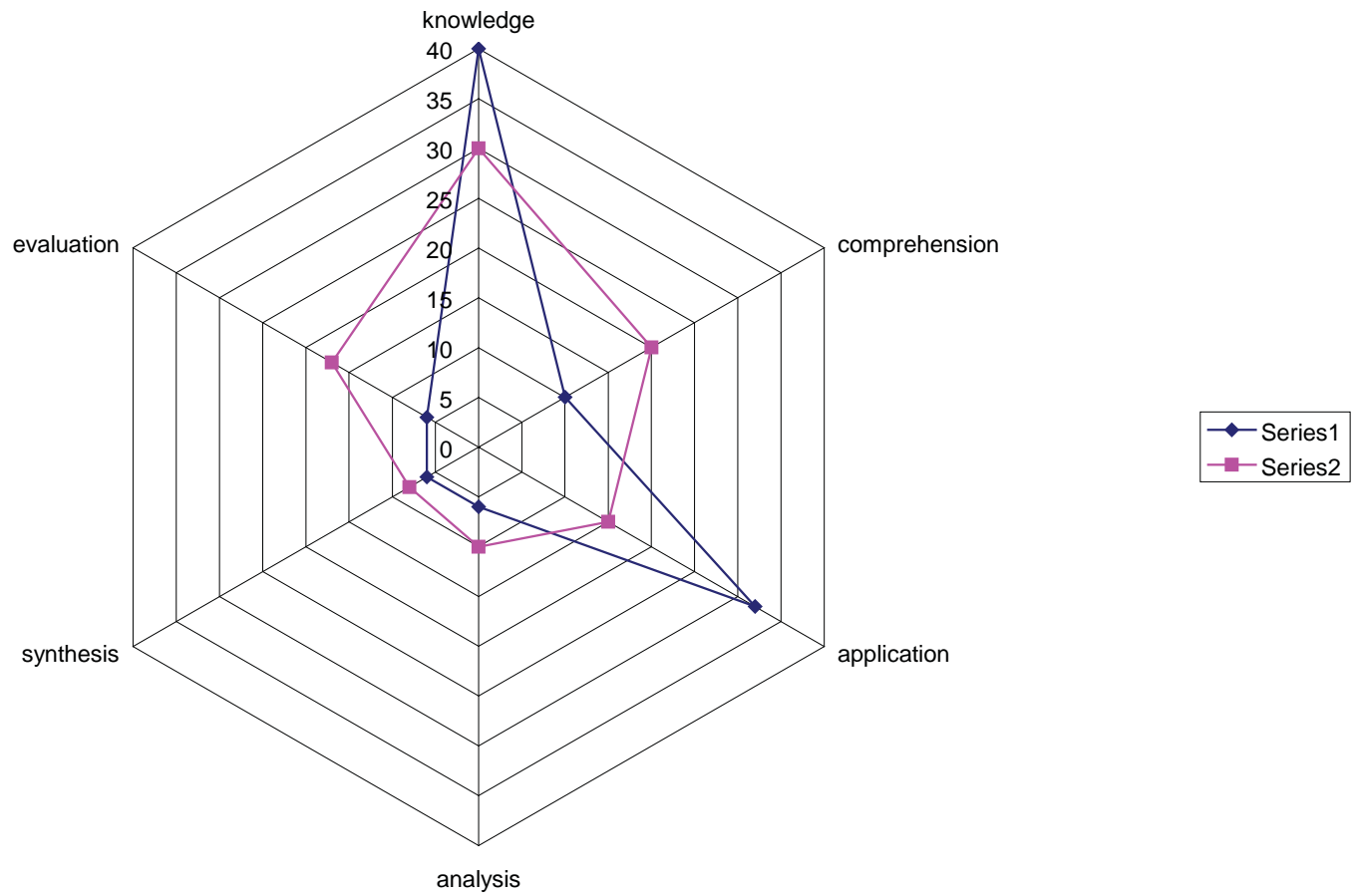
5. Synthesis: arrange, assemble, collect, compose, construct, create, design, develop, formulate, manage, organize, plan, prepare, propose, set up, write.

6. Evaluation: appraise, argue, assess, attach, choose compare, defend estimate, judge, predict, rate, core, select, support, value, evaluate.



The goal here is to attain higher level thinking skills such as Application Analysis Synthesis.

Bloom



	knowledge	comprehension	application	analysis	synthesis	evaluation	words used
set1	40	10	32	6	6	6	8
set2	30	20	15	10	8	17	18

The raw data above is depicted as percentage in a double doughnut chart on the previous page and a double radar chart here. The data is skewed from set1 to set2 as there were different instructions. The total average words used per student in set1 was 8 while set2 had an average of 18.

Analysis of Data

Part I The Questionnaire

I used a Likert scale to find the opinion of the students I had. I carefully constructed 28 questions that I considered important. I followed some guidelines in the construction of the questions and I attempted to relate them to Blooms guidelines or the procedures I found about Project Based Learning. After I collected the data I found that the analysis of this data was different than I had perceived. I was about to take the mean of the questions when I thought that it seemed a bit strange to do so. I found on line information to guide me into looking at the mode or median. This seemed to obliterate much of the individual data to me. I still found it valuable to get the information and it was also important for the students to answer the questions. Just asking the question made some of them think differently than they would have if I had not asked the questions at all. I also found information that each survey could be evaluated to see if the student had a positive or negative bias. I did not carry out the individual student analysis as it seemed somewhat pointless at this juncture.

Part II Blooms Taxonomy

I used Blooms Taxonomy to find the opinion of what the students thought they accomplished in my class. I required a one page essay on what they had accomplished for the term. Since this assignment counted as a final exam grade I got some pretty good essays. When I first used this method I gave few guidelines on what the essay needed to contain. On my most recent attempt I gave them a list of terms and required them to use between 12 and 20 occasions of usage of these terms. This was not the best way to gather data as I had changed the method of gathering the data midstream, but I found even better essays and gathered much more data as a result. In short, I learned how to gather data in a better and more meaningful way. This data allowed me to relate my work to our building school improvement goal of stimulating higher level thinking. I now had more concrete data to back up my claim that this higher level thinking was occurring in my classes. I will probably continue to tweak my method of data collection, but I have found an important gateway to its collection and assessment.

Part III Observations

The most important data in my mind is the data I have gained from observation. Being a math instructor for many years it seems a bit strange hear me say that the best way to gather data is by observation! I think that if I were able to do it all again I would know what I needed to gather data on a bit better. I have seen a tremendous amount of change in my teaching as well as the learning of the students. This is in part due to the fact that there existed no curriculum for the subjects I taught. Yes, there were national technology standards, but they were pretty generic in nature and offered no real help. It all boiled down to my time and energy of building up what I thought would give students the edge on skills needed for the 21st century.

Results of the Study

The study showed that Project Based Learning is a viable method to learn vocational skills. These skills are not limited to Knowledge and application but also application, analysis, synthesis, and evaluation. The data clearly show that the higher level skills are being used and are in fact increasing.

Limitations of the Study

Statistics of small numbers makes the data mathematically insignificant. That is not to say that the data does not have value. It is simply a spark and not an all out bonfire.

Observations and Recommendations

The most interesting thing to me is our technological ability to currently allow self publishing. The term Desktop Publishing was coined to name the ability of each individual to create publishable items right on their home computer. We are all still stuck in the typewriter generation, but the new technology is allowing us to slowly escape that. People all over now have a chance to create their own books, websites and pictures and have them seen around the world. All of my efforts have been to improve my students chances at filling a seat in this new world. Regrets? I wish I would have gone electronic from the beginning instead of lugging around the hardcover portfolio.

Support

Support was given by fellow teachers Donna K and Jamy Marski. I also collaborated extensively with Jeff Bogardus. I gained insight into Blooms Taxonomy from Pam Nutt. I have always recieved support from my principal and friend Dave Johnson. I could not have done any of this research without the support of Ralph Hansen.

Resources

In addition to the resources listed in my Literature Review, I also came to depend on Blooms Taxonomy more than I would have previously thought . Other human resources have been listed previously under Support.

Project Based Learning

Ken Bos
MAT 581
Sept 2008

Some of the research questions I had when starting this review were:

How we can change our instruction to impact students?

What do we know about project-based learning, and why should it be considered a viable approach to learning?

What methods can motivate students to higher levels of learning?

What data exists that can be used to make project based learning a success?

How can instruction become more efficient for all learners with widely different skill sets?

How can cognitive load be managed to increase efficiency in learning?

As I continued my research I garnered even more questions than I generated answers

What is Project-based Learning?

Project-based learning has a number of different definitions in the literature I have read. Generally speaking Project Based Instruction is an inquiry-based approach to teaching and learning. A real life authentic project is the centerpiece of the methodology. Problem, and Inquiry-based Learning models are closely related and sometimes used interchangeably with PBL. (<http://eduscapes.com/tap/topic43.htm>) Project-based learning (PBL) is a model that organizes learning around projects. Projects are complex tasks, based on challenging questions or problems, that involve students in design, problem-solving, decision making, or investigative activities; give students the opportunity to work relatively autonomously over extended periods of time; and culminate in realistic products or presentations. The implementation of a project-based curriculum moves instruction from teacher-directed to student-led activity using the application of hands-on or minds-on to learning. Through project-based learning, students practice problem solving in the context of "real-world" projects, which often address real world concerns and/or student interests. In the context of solving problems related to the project, students apply and integrate content in a variety of subject areas, utilizing science,



mathematics, language arts, technology, software, geography, social studies and the fine arts to research and complete the project.

The diversity of defining features coupled with the lack of a universally accepted model or theory of Project-Based Learning has resulted in a great variety of PBL research and development activities. This variety presents some problems for a research review. First, as Tretten and Zachariou (1997) report in their observation report on Project-Based Learning in multiple classrooms, the variety of practices under the banner of PBL makes it difficult to assess what is and what is not PBL, and whether what you are observing is a "real project." For Projects implemented in the project-based curriculum must include a range that allows students to gain an in-depth understanding of content tied with skill development (research skills, problem-solving skills, collaborative learning skills, process-oriented skills in science and mathematics, skills associated with investigation, technology application skills etc.). Project topics need to relate to students so they are intrinsically motivated and engaged in their own learning, pursuing interests, questions and ideas associated with the project.

The intended student outcomes of project-based learning are to develop problem-solving strategies, to experience the connections of classroom learning to life experiences, to gain an in-depth understanding of the inter-relationships of content, to apply collected data to decision-making, to organize procedures and research that facilitate the continual building of knowledge and ideas related to the project and to develop strategies for collaborative information gathering and problem solving. Of course, a successfully implemented project is also a desirable outcome

What are the benefits of project-based curriculum?

- Students to become empowered active learners that participate in commonly held objectives.
- Students develop inquiry-based strategies that can be applied in multiple ways.
- Students develop higher-order thinking skills.
- Students become a member of a community of learners.

- Students become self-directed learners.
- Students realize the inter connectedness of content.
- Students realize their role in the community.
- Students are empowered to learn, where the instructor is a coach, a facilitator.
- Projects make it possible to discover one's natural talent and personal interest.
- Projects make it possible to discover one's learning personality.
- Projects have a goal that is based on man's desire to be a winner. Self-satisfaction is a powerful motivator.
- Projects are learning tools that is motivated by curiosity.
- Projects give students opportunity to learn with real objects.
- Successful projects are the results of failure and learning to bounce back from it.
- Projects require a plan, which includes ways to acquire needed knowledge and skills.
- Projects require all the motor skills that it takes to start and run a business or become a valuable employee, skilled or unskilled.
- PBL Overcomes the dichotomy between knowledge and thinking, helping students to both "know" and "do."
- PBL Supports students in learning and practicing skills in problem solving, communication, and self-management.
- PBL Encourages the development of habits of mind associated with lifelong learning, civic responsibility, and personal or career success.
- PBL Integrates curriculum areas, thematic instruction, and community issues.
- PBL Assesses performance on content and skills using criteria similar to those in the work world, thus encouraging accountability, goal setting, and improved performance.
- PBL Creates positive communication and collaborative relationships among diverse groups of students.
- PBL Meets the needs of learners with varying skill levels and learning styles.
- PBL Engages and motivates bored or indifferent students.

What are the roles of teachers in project-based curriculum?

Teacher's Role

Although the teacher's role is less that of an instructor who transmits information and organizes activities for practice and more that of a guide and a facilitator, it is a critical role, nevertheless. Projects require that teachers get to know their learners' interests. Teachers must listen for what has been called the teachable moment, that point in a discussion when learners become excited about a topic, and start asking questions such as "why is this happening and what can we do about it?"

Facilitating project-based learning requires the kind of leadership skills that allow teachers to help a group of learners to move in the direction that they want to go, pointing out potential pitfalls or making suggestions without getting defensive when students decide they like their own ideas better. It makes a difference if teachers possess a tolerance for ambiguity, some skill in helping learners negotiate conflicts, and enough self-confidence to not give up when a project peters out or refuses to come together.

Not all projects are successful. Some teachers are too inexperienced to guide the process well. They may expect too much ability on the part of the learners to take control of the project without having laid the necessary groundwork or they may fail to let students take the lead when they can. Learners do not necessarily take to project work wholeheartedly, either. Some may feel teachers are abdicating their roles if they do not provide answers, or they may not want to learn with and from their classmates.

- Provide opportunities for and guide student inquiry
- Provide suggested resources (research, people, community)
- Facilitate learning
- Propose possible resolutions to conflicts or "dead ends" asking leading and open-ended questions,

- to help the students explore the richness of the situation and to help them develop their critical thinking.
- helping students reflect on the experiences they are having, because reflection improves problem solving.
- monitoring progress.
- challenging their thinking, so as to nurture deep learning and a search for meaning and so that they develop their critical thinking skills.
- raising issues that need to be considered.
- stimulating, encouraging and creating and maintaining a warm, safe atmosphere in which individuals will be willing to share experiences and ideas without fear of being ridiculed.

PBL for Workplace Preparation

Teachers and students concerned about life skills and the more functional components of literacy may choose projects that help learners meet critical economic needs by assisting them in adapting to new environments or function more effectively in familiar ones. These projects often result in guides and strategies meant to make it easier to navigate systems. Examples include a handbook written by students for new students, a list of tips and hints on how to deal with the admission requirements of a college or training institute, or a description of different ways to fight an eviction notice or challenge a traffic ticket. As learners conduct research into what it takes to negotiate bureaucracies, they acquire the knowledge and skills associated with functional competence in literacy, while developing strategies for decision making.

Data and anecdotes of Benefits and Skill Gains

In interviews conducted with teachers involved in successful project-based learning, some themes surface: at the beginning of and the end of projects, learner enthusiasm seems to be increased, revitalizing classes and teachers. Since students have signed on to an issue that interests them, motivation tends to be high. As learners get involved in the inquiry process, they become curious about answers, often digging deeper into a topic

and spending more time on task than they do when a teacher assigns group work. A shared work ethic is created. Teachers report that learners frequently encourage each other and lend moral support as they face the frightening prospect of a public presentation. In the end, they come through when a presentation is scheduled, appearing well prepared and on time and communicating their ideas confidently and effectively, despite any nervousness they may feel .

Others who have also talked with learners report outcomes in various domains, including attitudes, self-efficacy, and "can do" skills (Schwarz, 1997). When asked what project work has meant to them, learners mention a greater awareness of their own abilities to research and report findings; the confidence that comes from being able to map out a project and see it come to fruition; the joy and frustration of working with others; the pride in gaining important knowledge and insights; the enthusiasm generated by mastering new technologies; and, in the case of presentations of a personal nature, the excitement of sharing a story worth telling.

Preparing students for careers in highly technical fields is a delicate matter. Many persons have previously constructed knowledge based on non-viable models from their own experiences. The study of computer programming and software deals with a very detailed model created by another person. It is the application of design principles to novel situations that can prove to be difficult given the individual nature of construction of knowledge by learners. An instructor must insure that the model of computing derived by the learner is viable and relatively complete.

"For students who have constructed personal models with inconsistencies, instructors must question the student to carefully discover the theory the student is currently operating under in order to align the students' model with that of a functioning programming structure." (Ben-Ari , 2001)

Limited Research

While numerous research studies have demonstrated

the positive effects of similar forms of group learning on academic skills of school-age children and youth (Johnson and Johnson, 1989; Slavin, 1990), it is difficult to find large scale studies that have been conducted with learners engaged in project-based learning. However, sufficient anecdotal evidence supports the contention that project-based learning fosters the skills named by the Secretary of Labor's Commission on Necessary Skills

Research on engaging learners as multimedia designers has had positive results in helping develop cognitive skills on a higher level.

(SCANS) as those deemed necessary to succeed in high performing workplaces. To completely assess what learners take away from project work, in terms of

both group and individual learning, we would need to develop performance-based assessments that capture the knowledge, skills, and strategies that learners attain against some level of standard, developed jointly by teachers, learners, and members of the community. I have not found studies that have been done comparing project-based learning in education with more conventional models of teaching and learning, so to what extent basic skills as measured by standardized tests or GED completion rates are affected by project-based learning remains an open question.

Possible Solutions

Motivating students to actively participate in knowledge acquisition and a more free market approach to selecting course work based on content rather than difficulty is a step in the right direction. Educators must take the lead in assisting this cognitive development, not just in disseminating knowledge.

Research on engaging learners as multimedia designers has had positive results in helping develop cognitive skills on a higher level. Although the environment of choice is quite a bit more risky for teachers because they are less structured and defined, the rewards are also greater for students. "Successful implementation depends on how such factors as the learners, the tasks, the context, the process, the coaches, and the outcome interact with each other. (Liu 2003 p.25)

Speaking more about choice for students in the curriculum, how much is enough? Each classroom is unique,

complete with teacher as well as student dynamics ultimate goal is for students to learn as much as possible in the given time period. Even considering the additional stress of individualizing instruction for students, "All parties concerned are satisfied and happy when students are able to execute a project that maximizes motivation, learning and technical prowess." (Parker, Holcombe and Bell 1999 p.235)

Beginning project based learning can be filled with uncertainties for the instructor as well as student. Dealing with open-ended outcomes can be difficult to grade. Studies suggest projects that are not brought to full completing can still be a successful learning experience. In a perfect world, all projects would be a resounding success, but that should not be the only criteria on which a project is judged. If it is not demanding enough, students don't have to learn any new skills to be a "technical success", therefore the original purpose of the project is thwarted. (Capon 1999)

Another facet towards a highly effective solution for fostering higher thinking skills is the emphasis of social interactions. The process of thinking out loud in front of a community of learners helps promote discourse and critical analysis.

"Collaborative learning strategies that extend past the structured modular time periods that free students to make inquiries and create without circular boundaries, when employed in a technology based classroom, are powerful cognitively-based tools for instruction." (Demiranda and Folkestad, 2000)

Details of Successes

Some general characteristics of project based learning are:

1. Learner owns the learning process.
 2. Learners think deeply to discover thoughts, truths or nuances hidden below the surface of the problem or project.
 3. Outcomes are not preconceived by the instructor.
- (Lankard 1995)

Other authors suggest an approach more focused on the high school learner. Doug Johnson (1999) suggests that good project based learning should have clear expectations and purpose, freedom of choice, relevancy to a student's life, creativity, varied research and finally the presentation of findings to a concerned community.

To document the process, a comprehensive journal on the iterations of the project must be maintained. Evidence of the development of the program into its current state is important as it shows ownership and authentic creation. It is especially important to a project that may not be brought to full completion because the learning process is evident in the journal. (Jalloul, 2000)

Of paramount importance to the authentic project based process is the delivery of the product to a real customer. Customer involvement stimulates a great deal more student motivation on a project as shown by surveys of students who participated in this type of learning. Students report developing communication skills, team work skills, time management, prioritization skills, problem solving, project management and quality assurance skills as a result of completing client-led software projects. (Parker, Holcombe and Bell, 1999)

How do we evaluate PBL?

The "Six A's" of Quality Project-Based Learning (Adriann Steinberg http://www.essentialschools.org/cs/resources/view/ces_res/85) can help determine if an exercise is worthwhile in PBL.

AUTHENTICITY

1. Does the project emanate from a problem or question that has meaning to the student?
2. Is it a problem or question that might actually be tackled by an adult at work or in the community?
3. Does it provide opportunities to create or produce something that has personal or social value?

ACADEMIC RIGOR

1. Does the project lead students to acquire and apply knowledge related to one or more discipline or

content areas?

2. Does it challenge students to use methods of inquiry central to one or more disciplines?
3. Do students develop higher-order thinking skills and habits of mind?

APPLIED LEARNING

1. Are students solving a semi-structured problem, grounded in the life and work in the world beyond the school?
2. Does the work require students to develop organizational and self-management skills?
3. Does the project lead students to acquire and use competencies expected in high-performance work organizations (for example, teamwork, problem-solving, appropriate use of technology, communications)?

ACTIVE EXPLORATION

1. Do students spend significant amounts of time doing field-based work on the project?
2. Does it require students to engage in real investigation using a variety of methods, media, and sources?
3. Are students expected to communicate what they are learning through presentation?

ADULT RELATIONSHIPS

1. Do students meet and observe adults with relevant expertise and experience?
2. Do students work closely with and get to know at least one adult?
3. Do the adults collaborate with one another and students on the design and assessment of project work?

ASSESSMENT

1. Will there be opportunities for regular assessment of student work through a range of methods (for example, exhibitions, portfolios)?
2. Do students reflect on their learning, using clear project criteria that they helped to set?
3. Are adults from outside the classroom involved in the assessment of the work?

Scaffolding

1. Explicit Expectations and Criteria
2. Are there clear guidelines for students to use in planning their project work?
3. Do students know how their work will be assessed?
4. Were students involved in the establishment of criteria for the assessment?

Implementing PBL

As a field, PBL is still in the developmental stage. There is not sufficient research or empirical data to state that PBL is a proven alternative to other forms of instruction. Based on evidence gathered over the past ten years, PBL appears to be an equivalent or slightly better model for producing gains in academic achievement, although results vary with the quality of the project and the level of student engagement. Also, PBL is not appropriate as a method for teaching certain basic skills such as reading or computation; however, it does provide an environment for the application of those skills

Good projects in classrooms encourage changes in the culture and structure of schools. Schools are under ever increasing pressure to raise standards, improve climate, and personalize education. PBL can contribute significantly to this process by motivating students to achieve, encouraging teacher collaboration, using the tools and language of project management and organizational change, and helping to incorporate school-wide learning outcomes into the curriculum. In particular, PBL fits well with current efforts to create a high-performance school culture that values both rigor and relevance. In addition, "projects are a great way to involve parents and community members in the educational process, a result that often leads to more support for the school and a better understanding of the needs of students." (Markham 2003)

A sample model for student assessment

Teacher Name:

Student Name: _____ Reviewer Name: _____

Date: _____

Project:

CATEGORY RESPONSIBILITIES

Appearance

- " I balanced design aspects with content.
- " I used only a few fonts.
- " I used my fonts in a consistent manner.
- " Titles and headings are easy to distinguish from other text.
- " The text areas and graphic areas appear balanced.
- " The graphics are easy to see.
- " Graphics are clear and not pixellated.
- " My background is not distracting.
- " Sounds and music are easy to hear.
- " Transitions are not distracting or boring.
- " There is not too much time or too little time between slides.
- " The slides look neat and use white space well.
- "

Organization I organized my ideas in a meaningful and logical way.

- " I gave a full explanation of my topic and subtopics.
- " I clearly answered questions people might have about the topic.
- " I included an introduction or Table of Contents.
- " I included a conclusion.

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