Enhanced Student Learning with Problem Based Learning.

James Hollenbeck, Associate Professor, Indiana University Southeast, Indiana, USA. And 2008-2009 Fulbright Fellow. Visiting Associate Professor University of Sofia, St. Kliment Orhidski, Sofia, Bulgaria.

Abstract: Science educators define a learning environment in which the problem drives the learning as problem based learning (PBL). Problem based learning can be a learning methodology/process or a curriculum based on its application by the teacher. This paper discusses the basic premise of Problem base learning and successful applications of such learning. PBL enables students to develop skills, and inquiry methodology to solve problems for the future. This important teaching application will better prepare our students to meet a global future.

1. Improve Science Learning with Problem-Based Learning

Science educators define a learning environment in which the problem drives the learning as problem based learning (PBL). PBL is used in multiple domains, i.e.: medical education (dentists, nurses, paramedics, radiologists, etc.) and in content domains as diverse as MBA (Bridges, E.M and Hallinger, P., 1996.; Stinson, J. E., & Milter, R. G., 1996.; Kingsland, A.J. 1998), and pre-service teacher education (Hemlo-Silver, 2004). This list is by no means exhaustive, but is illustrative of the multiple contexts in which the PBL instructional approach is utilized (Savery, 2006).

The origin of PBL education as it is practice today evolved from an innovative health sciences curriculum created at McMaster University in Canada. The program structures an entire curriculum promoting student-centered, multidisciplinary education and lifelong learning in professional practices.(Barrows, H.S. and Tamblyn, R.M. 1980; Savery, 2006) In education, this process is adapted and transformed so that the assignment is planned so that the students discover that they need to learn new scientific knowledge to solve the assigned problem. Problems can be assigned from the textbook as extension assignments or student initiated problems. PBL methodology does not require textbooks and encourage students to think out of the ordinary.

2. A Curriculum or Process?

The debate on the topic of PBL is a curriculum or process, is dependent on how the teacher uses it in the classroom. If it is the strategy of the teacher is to dedicate, the course to a series of selected and designed problems that demand the learner acquire critical knowledge throughout the course, PBL can be a curriculum and meet the standards set forth by schools and other governing bodies. The Illinois Mathematics and Science Academy (http:// www.imsa.edu/center/) has been providing high school students with a complete PBL curriculum since 1985 and serves thousands of students and teachers as a center for research on problem-based learning. The Problem-based Learning Institute (PBLI) (http://www.pbli. org/) has developed curricular materials (i.e., problems) and teacher-training programs in PBL for all core disciplines in high school (Barrows, H.S. and Kelson, A., 1993; Savery, 2006).

If the teacher chose to use PBL as one of several methods to integrate student inquiry with their current teaching methodology, then PBL is a process. The widespread adoption of the PBL instructional approach by different disciplines, for different age levels, and in different content domains has produced some misapplications
in addition, misconceptions of PBL(Mansley,G., 1999). Certain practices that are called PBL may fail to achieve the anticipated learning outcomes for a variety of reasons. Boud and Feletti (1997), and Savery (2006) described several possible sources for the confusion:

- Confusing PBL as an approach to curriculum design with the teaching of
- problem-solving,
- Adoption of a PBL proposal without sufficient commitment of staff at all levels,
- Lack of research and development on the nature and type of problems to be used,
- Insufficient investment in the design, preparation and ongoing renewal of
- learning resources,
- Inappropriate assessment methods which do not match the learning outcomes
- sought in problem-based programs, and
- Evaluation strategies which do not focus on the key learning issues and which are implemented and acted upon far too late.

Students engaged in self-directed learning strategies or team (group) participation skills that will enhance teamwork and life work relationships characterize by this learning process. The PBL process replicates a systemic approach of resolving problems or meeting challenges that students may encountered in life and career (Bridges, E.M and Hallinger, P., 1996.; Giljselaers, W.H., 1996).

3. Role of Students in PBL

One important outcome in PBL instruction is that the students assume responsibility for their learning. This important classroom management strategy, empowers the teacher, and reinforces the importance of self-discipline for the students. Students must be on task to successfully complete their project and meet team obligations. The indirect application of peer-pressure is present in PBL, application of positive motivation for the group or individual to be the best.

Ownership of student learning is integrated in the PBL approach, students are "charged" with the task of learning new information and applying it to "solve" their problem. They gain self-esteem in solving "their" problems and sharing their results with their peers and teachers. Often students, who do not do as well in the traditional didactic classroom, are successful in presenting to their classmates in their own ways.

4. Role of the teacher in PBL

Teaching PBL does not abrogate the role of the teacher in means. In fact, the teacher in turn becomes even more important in the students' learning they assist students in finding resources, act as tutors, and evaluators. The teacher becomes a mentor guiding the students in their problem solving efforts. This strategy of becoming an information facilitator and classroom manager replaces the traditional roles of teachers as knowledge providers. This frees the teacher's time considerably, to give them time to concentrate on individual assistance as they work with all students. Classroom management becomes a preventive and interactive process. Students are on task and this learning is enhanced (Kyburz-Garber, R. 2004; Giljelaersk, W. H., 1996, Savery, J., 2006).

5. Applications of PBL

Problems in the form of case studies are very useful for PBL as they can be scheduled and programmed to the needs of instruction. They can be extensions of lessons, results of media events that create "teachable

moments." These projects can later be developed or refined into science fair projects.

Case Studies a more elaborate methodology, involves more in-depth of learning and can develop in a thematic driven course.. Lessons developed in the case study can be comprehensive and involve an entire school. Many Science, Technology, and Society (STS) modules are developed around the case study plan. The Iowa Chautauqua Program, initiated in 1983, has trained K-12 science teachers in Iowa schools, as well as in other states and countries are based using problem-based learning (Blunk S. and Yager, R.E., 1990).

For ambitious students, problem-based learning research opportunities are an excellent way to promote interest in science. Talented and gifted students can and should be challenged to apply their science to solving problems. A former student, intrigued by photosynthesis, engaged in an investigation on "the effects of ultraviolet radiation on the oxygen production of Lemma spp."

I challenged my advanced level biology class to indentify, investigate, and present a research project as part of the course. The students completed the assignment as expected, but on encouragement of their teacher, they entered the regional science science/engineering fair. Imagine students who appear to be uninterested in school, can be excited by being able to choose a problem and apply what they are learning. The result of this class's participation in PBL resulted in the 1994 Quad Cities Science and Engineering Fair, Bettendorf, Iowa, having over 50 high school science fair posters and papers from a single school!

Another successful application of PBL was helping a problematic student. This student enrolled in physics and wanted to apply his newly learned physics to his first love, baseball. He was an excellent baseball player and wanted to know which baseball bats are better for hitting distance - aluminum or wood bats. The student researched the question and conducted his research experiments in batting cages. He presented to the instructor a twenty-page paper, typed and correctly organized with charts and tables. Every physics topic, he had learn, and was applicable was incorporated and correctly used in his results. The student spent over nine weeks working on the project and demonstrated his understanding of physics using a topic he felt comfortable with leading go the attitude of the student improved in the class as well. PBL was a positive influence on his learning and classroom behavior.

6. Conclusion

Students involved in problem-based learning, have the opportunity to acquire knowledge and become proficient in problem solving, self-directed learning, and can learn teamwork. Teachers using PBL have observed that it prepares students as well as traditional methods for learning and standardized exams (Maudsley, 1999). Research of classroom teaching shows that students taught in a PBL classroom do as well as their counterparts from traditional classrooms on national exams, and are better practitioners.(Duffy, T.M. and Cunnigham, D.J., 1996; Savery, J., 2006; Torp, L. and Sage, S., 2000). Problem based learning can be a learning methodology/process or a curriculum based on its application by the teacher.

As educators, we want our students not only to learn science, but embrace it and be able solve problems for the future. The bar for science educators is higher than ever for teaching science. We are preparing our students to meet a global future for students. Thomas Friedman's 2006 book, "The World is Flat", should be required reading for all educators. Problem based learning prepares our students for the future.

Cited Bibliography

Barrows, H. S., & Kelson, A. (1993). *Problem-based learning in secondary education and the Problem-based Learning Institute* (Monograph). Springfield: Southern Illinois University School of Medicine.

Barrows, H. S., & Tamblyn, R. M. (1980). *Problem-based learning: An approach to medical education*. New York: Springer.

Blunck, S and Yager, R. (1990*). The Iowa Chautauqua Program: A Model for Improving Science in the Elementary School.* Journal of Elementary Science Education, v2 n2 p3-9 Sum 1990.

Boud, D., & Feletti, G. (1997). *The challenge of problem-based learning* (2nd ed.). London: Kogan

Bridges, E.M., & Hallinger, P. (1996). Problem-based learning in leadership education. In L. Wilkerson & W. Gijselaers (Eds.), Bringing problem-based learning to higher education: Theory and practice. *New Directions in Teaching and Learning*, No. 68 (pp. 53-61). San Francisco: Jossey Bass.

Duffy, T.M. and Cunningham, D.J. (1996). Constructivism: Implications for the design and delivery of Instruction. In D. Jonassen (Ed.), *Hanbook of Research for Educational Communications and Technology.* New York: Macmillan.

Gijselaers, W. H. (1996). Connecting problem-based practices with educational theory. In L.Wilkerson & W. Gijselaers (Eds.), Bringing problem-based learning to higher education: Theory and practice. *New Directions in Teaching and Learning*. No. 68, Winter 1996 (pp. 13-21). San Francisco: Jossey Bass.

Hmelo-Silver, C. E. (2004). Problem-based learning: What and how do students learn? *Educational Psychology Review*, 16(3), 235-266.

Kingsland, A. J. (1989). The assessment process in architecture at Newcastle. In B. Wallis (Ed.), *Problem-based learning: The Newcastle workshop*. Proceedings of the ten-year anniversary conference (pp. 121-130) Faculty of Medicine, University of Newcastle.

Kyburz-Graber, R. (2004). *Does Case-Study Methodology Lack Rigour?* Environmental Education Research. Volume 10:1. 53-65.

Maudsley, G. (1999) Do we all mean the same thing by "problem-based learning"? A review of the concepts and a formulation of the ground rules. *Academic Medicine*, 74(2), 178-85.

Stinson, J. E., & Milter, R. G. (1996). Problem-based learning in business education: Curriculum design and implementation issues. In L. Wilkerson & W. H. Gijselaers (Eds.), *Bringing problem-based learning to higher education: Theory and practice*. New Directions For Teaching and Learning Series, No. 68 (pp. 32-42). San Francisco: Jossey-Bass.

Savery, J. (2006). Overview of Problem-based Learning: Definitions and Distinctions. *The interdisciplinary Journal of Problem-based Learning.* Volume 1. Number 1 (Spring 2006).

Torp, L. and Sage, S. (2002). *Problems as Possibilities: Problem-based learning for K-16 Education (2 ed.)*. Alexandria, VA. Association for Supervision and Curriculum Development.

Title

Woods, D. R. (1994). *Problem-based learning: How to gain the most from PBL*. Waterdown, Ontario: Donald R. Woods.