“Groups with Computers in My Classroom”

Aaron Bitler

Comprehensive Essay

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Dr. Ken Tobin, Supervisor and Science Education Advisor

Dr. Jeanne Vissia, Director Teacher Education
Teaching at University City High School (UCHS) has been a tremendous learning experience. I have learned much from my supervisor, my co-op, and perhaps the most from my students. My time in the classroom has served as a testing ground for me to put into practice the theories that I have learned in my coursework. When the students responded well to an activity, I could usually trace it to some theory or methodology that I learned in the Graduate School of Education at the University of Pennsylvania (Penn). When the students responded poorly to an activity, I could sometimes trace it to an oversight in my method. No lesson works perfectly, but I was able to learn and adapt my plans as I learned what worked best with different groups of students.

This paper will attempt to outline some of the major theories and methods which affect the way students learn. I will then try to relate a large classroom project which we ran in a physical science class at UCHS to the theories and methods which shape our practice as teachers. A strong emphasis will be placed on computers and technology in the classroom because many reforms today are, for better or worse, introduced with computers. And I believe that educational reform cannot be discussed without mentioning the role of computers.

**Theory**

John Dewey thought of education as growth. In the biological sense, growth has a limit, an end. The end product of education for Dewey was more growth. The end and the means are the same thing. Interpreting this relationship shows a cyclical pattern where new knowledge leads to more knowledge and new skills lead to even more skills. Growth begets growth. In one of his most comprehensive books on education, *Democracy and Education*, Dewey described education as humanity’s tool for building common social values and knowledge. Any group of
humans wishes to communicate with one another. This desire to communicate with each other brings about shared values and knowledge through inquiry and the construction of knowledge. In the United States, education prepares people to be citizens of a democracy and understand what that means. Education should prepare people to function in society successfully and for the greater good.

Joining these two views of education will illustrate my own theory of education. Education is another evolutionary tool man has created thanks to his large cerebrum. Unlike all other animals on the planet, we are able to impart large amounts of knowledge from one generation to the next. Because we have such ability, each new generation is not forced to rediscover everything the generation before it did. The children can resume researching or writing or composing where the parents stopped. This is Dewey’s idea of education as growth. Each new generation must be educated in the old knowledge of the group. The knowledge (growth) of the parents brings forth yet undiscovered knowledge and understanding (growth) from their children. Growth begets growth. Evolution has granted humans with the ability to step up a complex social system which can continue to exist, partly due to education.

**Methodology**

Presently, the public educational system of the United States, for the most part, is the same industrial model that has existed for over a century. Then, schools were viewed as factories that mass-produced future young workers that could read, write, and do elementary math calculations. Students were not expected to think or reason or solve problems. Similarly, students today are expected to memorize historic facts, rules of grammar, and laws of nature and repeat them on exams. “American schools are organized into subjects, taught in predictable units
of time, arranged sequentially by grade, and controlled by standardized tests." The students know exactly what is expected of them during different times of the day. The structure is many times rigid, inflexible, and uninspired. English class is not chemistry is not music. Classes do not overlap. Students, generally, are not expected to work together as a rule. Assessment is determined by the amount of knowledge an individual can successfully repeat without the help of books, classmates, calculators, and other resources. This bleak view of schooling is changing rather quickly because reforms which have existed for many years are finally spreading.

**Educational Reforms**

*Constructivism*-- The economy is no longer supported by a large production sector. Workers need to have skills other than reading and writing. They need to be able to take in information, analyze it, identify problems associated with it, and then construct solutions for the problem using outside information if required (as lawyers, architects, musicians, advertising agents, and police officers do). The best way to train people to do this type of thinking is to teach them reading, writing, and arithmetic in a manor that requires construction of knowledge into clear outcomes.

Giving students authentic projects that require complex thought processes promotes constructive thinking, multidisciplinary work, as well as student interest. It stands to reason that students, who are given a project to propose solutions to a local environmental problem, will be more interested to learn the chemistry of lead, if the problem exists in their neighborhood. If the project has no direct impact or tie-in with them or their life, what is the student’s interest in the project? Projects should, when possible, reflect the real-life aspect (authenticity) of the student’s life and surroundings. Project based learning also fosters higher order thinking by forcing
students to assimilate many different types of information to form integrated and usable knowledge. Assessment is based on performance, as opposed to memorization of discrete factoid knowledge units.

**Collaborative Learning**—Constructivism lends itself to other reform elements. When given a large project to work on, it is good to have fellow classmates to help. Collaborative learning fosters communication between students and it allows students to work together on projects that none of them might have been able to complete alone. This reform is a dramatic switch from individual performance based assessment. No longer would it be possible to grade a specific child on general knowledge learned from a single project or a lecture. The learning is a **cooperative** enterprise where students work together and learn about a broad range of topics by investigating a unifying question.

**Inquiry**—Inquiry is the basis of constructivist reform. Krajcik, Sosoway, Blumenfeld, and Marx describe project-based inquiry experiments best as: opportunities [for students] to find solutions to real problems by asking and refining questions, designing and conducting investigations, gathering and analyzing information and data, making interpretations, drawing conclusions, and reporting findings.²

Students are given a realistic problem or question and they must find the answer. Inquiry and learning take place in the acts of proposing tests, asking questions, using tools, and finding an answer. The students must **discover** the answer via their own research, cognitive strategies, and inquests. Inquiry is gaining acceptance as the best way to teach science in the laboratory. No longer do new experiments call for the teacher to direct students with a recipe book for wet chemistry. The students, collaborating in groups, investigate physical properties of chemistry by sharing prior or recently discovered knowledge. In this fashion they are able to draw solid
conclusions from abstract thought processes. The teacher is a facilitator, not a disseminator of knowledge.

*Communication*-- When students are working on a project, internal group communication is essential for project-based inquiry experiments to succeed. Communication with other students can help students find fresh ideas and spark creative solutions to problems. Professionals in the outside work force are also a great source of background information in their respective fields. If students were testing the pH of soil on school grounds to try and ascertain why grass only grows in certain areas, input from a chemist, soil geologist, or biologist would be a unique source of information the students would not normally have. Interactions with professionals in the real-world, to answer real-world questions, is another way to add authenticity to projects that hold student interest.

*Student Interest*-- Unless students are engaged in a topic, it will be difficult to keep student interest on a project or topic for any period of time. It may not seem obvious to most teachers how wrestling or movies can be related to science, but they can be used to hook the students’ interest in class. Two more obvious links are the links with physics. Wrestling utilizes the physics of motion and motion pictures can be used to introduce optics.

*Bloom’s Cognitive Taxonomy*-- Of particular interest to educators should be Bloom’s Taxonomy. Students in a standard classroom are asked to memorize discrete facts rather than learn trends or understand concepts. The spectrum of learning on Bloom’s Taxonomy range from simple recall to complex synthesis of knowledge. Teachers should utilize Bloom’s Taxonomy to plan lessons that will force students to think more about the material they working with in class. The farther along the taxonomy the students are asked to work, the better they will understand the material. A student who is asked to fill in multiple choice questions is less likely
to be able to take two ideas from the chapter or book or lesson and put them together in a way that demonstrates knowledge and understanding of each part. Despite what lovers of the multiple-choice quiz may believe, life is not like a multiple-choice quiz.

<table>
<thead>
<tr>
<th>Major Levels of Bloom’s Taxonomy</th>
<th>Description</th>
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<tbody>
<tr>
<td>Knowledge</td>
<td>The learner must recall information (i.e. bring to mind the appropriate material).</td>
</tr>
<tr>
<td>Comprehension</td>
<td>The learner understands what is being communicated by making use of the communication.</td>
</tr>
<tr>
<td>Application</td>
<td>The learner uses abstractions (e.g. ideas) in particular and concrete situations.</td>
</tr>
<tr>
<td>Analysis</td>
<td>The learner can break down a communication into its constituent elements or parts.</td>
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<tr>
<td>Synthesis</td>
<td>The learner puts together elements or parts to form a whole.</td>
</tr>
<tr>
<td>Evaluation</td>
<td>The learner makes judgments about the value of material or methods for a given purpose.</td>
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This table is modified from a table on the St. Edward’s University Center for Teaching Excellence website.³

**Technology in the Classroom**

Data shows that filling schools with computers is a bandwagon approach to improving education. From 1981 to 1991, the percentage of schools that had at least one computer rose 80% from 18% to 98%.⁴ The average number of student per computer dropped from 125 in 1983-84 to 18 in 1991-92.⁵ But parents and educators alike must keep in mind that computers do not teach. As Gavriel Salomon and David Perkins write, “Computers in and of themselves do very little to aid learning.”⁶ A teacher who uses a computer merely as a digital blackboard is not utilizing the potential of the technology. Nothing new is being accomplished; there is no reform. The computer must be used effectively in a classroom environment that is conducive to learning and in a way that interests students.
Computers in Reform

Student use of computers to complete projects enhances the authenticity of the project itself, because computers are such a major part of the everyday world and the workforce. Familiarity with computers is a good skill to learn while in school because of the many jobs and careers which expect new employees to have a working knowledge of computers. Computers can be used in all aspects of constructivist project-based reforms. The five key features (based largely on the ideas of Bloom’s Taxonomy) of technology in project-based learning, according to Krajcik, Sosoway, Blumenfeld, and Marx, are:

1) a driving question, anchored in the real-world should draw the students’ attention.

2) investigations that allow students to ask and refine questions discussion/debate, experimentation, data gathering

3) artifacts that allow students to learn concepts, apply information, and view knowledge in many ways use of books, journals, newspapers, calculators, video, and computers for data analysis

4) collaboration among students, teacher, and others in the community communication of knowledge

5) technology that supports students in data gathering, data analysis, communicating and document preparation

Except for feature 1), technology is at every step of the way. Computers and other technology can expedite the gathering, analysis, communication, and presentation of the final constructed product. With proper sensors, Texas Instrument graphing calculators and computers can record measurements of velocity and acceleration, pH of a liquid over time, and temperature. These numbers can then be listed, plotted, graphed, and analyzed in many ways with a computer to check for patterns, anomalies, trends, and relationships. Sets of different data, like the pH of
soil and the height of grass at specific points along a line on the schoolyard, can be viewed together to check for any correlation. Reporting the answers or conclusions, in document and/or presentation from, can be made unambiguously and concisely with the help of the computer.

Simulation programs can be run on computers, when doing an experiment might not be safe or economically feasible. High school students should not nitrate $p$-nitrotoluene in chemistry lab, as chemistry students do in college to verify the presence of $p$-nitrotoluene. If the reaction is heated too much, stirred too vigorously, or allowed to proceed for an extended period of time, the desired product, dinitrotoluene, will be further nitrated to form trinitrotoluene (or TNT). Dangerous reactions, trips to the moon, or dissections of animals can all be simulated on a computer.

Computers can also be used for communication and data retrieval on the Internet. The Internet is a vast landscape of information and knowledge. The Chemical Abstracts Service (CAS), the world’s largest index and most comprehensive database of chemical information and one of the largest scientific databases in the world, is now online. The complete CAS database is accessible from any computer that is hooked up to the Internet. CAS is not inexpensive, but schools and colleges can provide access to the database to their students for free, at a discounted educational institution price to the college. But not all information on the internet is correct or even appropriate for students. The American Chemical Society controls CAS and the Encyclopedia Britannica online is controlled by the Encyclopedia, so content on these sites is carefully monitored, but not all sites on the Internet can be trusted for accurate or truthful content. Because the Internet is a forum for free-flowing ideas, one must be careful when accessing and referencing information that is not from a reputable source.
The Internet allows for the greater possibility of communication with entities outside of the school. The community that the school belongs to and works with has the potential of being expanded via virtual communities to include other schools and professionals in specific fields. Classrooms from different parts of the country can participate in soil, wildlife, climate, or some form of regionally distinct study and share the results over the Internet with each other. Networking schools together can precipitate multiculturalism across school boundaries and hopefully foster better understanding between otherwise separated children. Teachers networking with other teachers could help each other out by lending advice, tips, and discussing curriculum.

**Teachers and Technology Reform**

*The Classroom*—All the reforms so far discussed have been about moving the classroom from a teacher-centered class to a student-centered classroom. No longer should the teacher be the center of attention, emphasizing the memorization of discrete bits of information without interaction with other students. The teacher should cease being the authority for all knowledge in the classroom and take on the new role of “facilitator of constructive knowledge”. The instructor’s ego may prevent the teacher from easily relinquishing the status of bestower of all knowledge.

In the student-centered model, students are the center of the classroom. Some teachers find it difficult to accept that they should not be the center of attention. They feel the students will misbehave if they are not the central focus of the class. Maintaining the discipline of six groups of five children spread all over a room is much more difficult than keeping a room full of thirty students quiet, facing forward. Especially when the collaborative groups are all working
on similar yet different real-world questions, while the students in the teacher-centered class are quietly doing their problem sets facing the front of the room. It would be total chaos to a teacher that is set in their comfortable pattern of teaching. Certain teachers are well versed in their field of interest and are not happy with the prospect of being asked a question for which they have no answer.

The classroom should be redesign for student-centered project-based learning. The teacher will have to learn that all students, regardless or whether they are learning disabled or disciplinary problems, should be put into heterogeneous project groups. Dividing students by ability only prevents certain children from developing higher-order thinking and reasoning skills. When the students are working on a project, the facilitator must not give answers to the students, because the act of formulating the solution is all part of the learning process.

Developing constructivist-outcome curriculum is difficult to do when the only materials one is familiar with are problem set books and spelling lists. These materials do not lend themselves to project-based exercises. Teachers tend to only use and teach what they know and are familiar with. They tend to teach the way they were taught. They have no real idea how to plan a collaborative inquiry because it is not something they have ever experienced. Reforming teachers means teaching them how to teach all over again, using constructivist style of instruction.

**Our Classroom**

In our classroom we tried to address as many of the points as I have discussed in this paper as possible. The fifth period ninth grade physical science class was a very difficult group. It was the end of the day. None of the students was in a particularly good mindset for learning
Newton’s Laws of Motion. As our time with the students neared its end, it was apparent that we needed to end the year with a project that would keep their attention and adhere to the standards by teaching them physical science. Inspired by a Thursday seminar, Mr. Corcoran and I decided to try a Webquest.

Dewey wrote about psychology as it related to education. In one of his papers Dewey wrote:

> When pupils study subject that are too remote from their experiences, that arouse no active curiosity, and that are beyond their power of understanding, they begin to use a measure of value and of reality for school subjects different from the measure they employ for affairs of life that make a vital appeal.  

We decided to follow Dewey’s warning and try to grab the students’ interest with something that they might enjoy. They were going to use the Internet to conduct a Webquest about roller coasters. We had discussed roller coasters many times to illustrate different types of motion and the students were able to latch onto those examples. They had all been to Dorney Park, Wildwood, or Six Flags and knew what we were talking about. Even the students that were too afraid to get on roller coasters understood the ideas we were trying to teach them when we used the roller coaster as an example. Dewey might have needed a lot of words to say a simple thing, but we got the point. Find a hook.

First off a Webquest is a lesson that is entirely on-line. San Diego State University has a project called Webquest which posts lessons designed for the web to a webpage (http://edweb.sdsu.edu/webquest/webquest.html). The Webquest we decided to use was called Roller Coaster Madness (http://www.esc2.net/TIELevel2/projects/roller/). Although it was intended for middle school students, our ninth graders were able to benefit from it with a little modification. From the Roller Coaster Madness page, one is faced with Teacher Resources and
Standards links. The website teaches any instructor unfamiliar with computers how to use the
Webquest in class and includes sample handouts and worksheets. The Standards, while they
belong to the Texas State Essential Knowledge and Skills, are similar to the Philadelphia
Standards and outline the skills and knowledge the students will be learning upon completion of
the project. Project-based learning should never lead to the sacrifice of standards.

Roller Coaster Madness requires that students be separated into groups which we called
research teams. Each team had a name corresponding to an amusement park. We decided to
handpick the students for each group to create heterogeneous mixtures. We mixed up behaviors,
study habits, and genders as best we could. This forced us to make judgements which we were
uncomfortable about, but we did not want the make-up of the groups to be left to chance. When
the groups were assigned there was vocal disappointment form students who did not wish to
work with “stupid” students or those who “never work.” We did our best to keep the groups
together, but Mr. Corcoran and I eventually decided that a few under the table changes would not
hurt the overall effect of the project. The teams were together to allow students to work in
groups toward a common goal. The project forced the groups to communicate internally and at
times with other groups. The students had to collaborate with each other to finish the project.
After the teams were formed, the project commenced.

The students followed the directions on the Roller Coaster Madness website. Each day
there were instructions for the teams to follow. The team members were all given different jobs
on the team: Historian, Designer, Safety Coordinator, and Engineer. The students were to use
the links the Webquest provided for their research. For this project, the Internet served as the
source of artifacts from which the students would draw basic knowledge of the material.
Because instructors had already found terrific Internet resources for this project (linked form the
Webquest site), the students were not forced to search randomly for pertinent information and, therefore, were less tempted to wander around the Internet on sites that were not appropriate for school. Close supervision of Internet use was required in the computer lab.

The purpose of the project was for the students to investigate their parts of the roller coaster story and share it with one another. In sharing their knowledge, the students where to synthesize a small scale roller coaster of their own. The students had to research history, energy, motion, safety (and as a result, accidents), and materials. By doing the project, they were learning about physics, history, and properties of materials without being bored into misbehaving or sleeping. A few of the students really got into their roles as researchers and emailed some of the webmasters of the resource sites for more information. It is a pity no one responded, but I believe interaction with outside professionals would have increased the success of the inquiry process.

Before building the final product, Mr. Corcoran and I decided that we should have a design sharing-out day. Although this was not part of the official Webquest schedule, we thought that getting everyone involved in critiquing each other’s work might add to the value of the lesson. We wanted to the student to present the material they had researched on the web and show the class the “blue prints” of their coasters. Due to limitations in our classroom, the students were unable to use computers to present their findings. But they were able to model sample roller coasters on Internet sites that were linked from the Webquest site. After they had modeled their coasters on the Internet, we asked that they draw diagrams of their coasters on poster board and make presentations to the class.

The presentations were taped so the students could then evaluate their own presentations and evaluate their reactions to others presentations. Habits of mind in science, were topics we went
over many times in class. We wanted the students to judge their own behavior on paper as they watched the video, knowing that we would read what they had to say about themselves. We were worried about fights possibly breaking out between students who would not appreciate peer critique, but the students all reacted well. The students presented well and then argued their points against peer critique. Some of the groups would simply not believe the advice of their peers, but no matter how heated the debates got, class was never total chaos. The benefit of having the students analyze each other’s work and collaborate between teams added to the reality of the project. If any of the students were to go into the sciences, they would be familiar with peer review, if only at the classroom level.

After the students had been given cardboard boxes, tape, glue, the tubing to make a track, and a large marble (the coaster), they set out to construct their own mini-coasters. The teams where given four days of 90 minute classes to construct a final coaster. On the fifth day, we taped our second presentations. The presentations of the final coasters were not as informative or rich with content as the preliminary presentations were, because most of the material had already been covered many times in the course of the project. Plus there was little room for debate; either the coaster worked or it didn’t. All of them worked.

Content was never overlooked. Mr. Corcoran and I did not trust that the students would learn the physics behind roller coaster design without grades. The students themselves wanted to know how we were going to be grading them. They wanted to be sure that their teams would not affect their personal scores. While we did promise them that the work they did in their teams would influence their grades, we gave them plenty of work to do independently. They received individual grades for the research which lead up to their team presentations as well as a team grade. We also had weekly quizzes which were designed to test their knowledge of the content.
material: linear and centripetal acceleration, velocity, potential and kinetic energy, friction, gravity, etc. The quizzes also gave us indications where the students were having trouble and where the project was not able to help them. Hooking the children into a project is a terrific method to teach students, but it should never lead to a decrease in the ability of the class to adhere to the standards.

**Conclusion**

Education is an extension of evolution. It allows humans to pass civilization down to its children. Civilization is not just classes in history, chemistry, literature, with a language course tacked on at the end of the day. Civilization is based on Dewey’s idea that people, placed together, wish to communicate. The more advanced the civilization, the more advanced the modes of communication. In a world that is becoming smaller and smaller with every new communication innovation (technology/computers/Internet), we should prepare our children to function in a civilization that expects them to function as part of a team.

Today, people do not work alone when they go to work. People work as parts of teams. Teamwork is a very difficult thing to teach in class, but it can be incorporated into classes that already exist in the form of group work. If the reform is taken to the next level the groups should be working on project-based inquiry. Students should become more comfortable working in groups to produce a finished product based on their own research. If education is preparing them to function in the “outside” or “real” world, then they should be ready to communicate with others, share their ideas, gather information from others and formulate their own opinions and conclusions.
1 Kozma and Schank, 4.
2 Krajcik, Sosoway, Blumenfeld, Marx, 32.
3 http://www.stedwards.edu/cte/bloomtax.htm
4 Means, 1.
5 Means, 2.
6 Salomon and Perkins, 113.
7 Krajcik, Sosoway, Blumenfeld, Marx, 33-34.
8 Barron and Goldman, 84.
9 Dewey, 226.
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