Basic Education in the Philippines faces a lot of challenges. The changes in the curriculum, limited IT resources and spiraling changes and improvement becomes overwhelming for administrators and teachers. Today’s education also presents new pedagogies. The resurgence of the constructivist model has brought about cooperative and collaborative learning, multiple intelligence, discovery learning, and project-based learning, to name a few. Some educators have taken a more creative approach by allowing technology to play a role in the teaching and learning process.

The paper will present several experiences and possible approaches in integrating technology and the lessons learnt. The first presentation is on laboratory automation at Don Bosco College Canlubang. The college, through the help of David Vernier and his company, made use of sensors, attached to a computer, to simulate science laboratory measuring devices. The high school department upon using the devices has observed that time was gained for analyzing experiment results, which were recorded in the computer, and students found the discrete sensors more engaging to work with. The next is an experiment done with some students of Tondo High School at Manila. The experiment modeled collaborative learning through correspondence and group work. Participated by several schools around the world, with the initial objective of learning English as a second language, the group engaged itself in the research for cultural approaches to dealing with SARS. Third, is the effort of Genetics Computer Institute to assist schools in doing IT-integration. The work focuses on building lesson plans for core learning subjects that makes use of technology in the process. The model presents using the computer laboratory as a venue to extend the study of Math, Science, English or History.

School administrator, teachers, parents and students need to get their act together in order to build a learning society that collaborates with each other given the limited resources at its disposal. The paper will conclude with possible directions and researches that can jumpstart the basic education industry to a sustainable ICT integrated model.

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Introduction

Today’s education faces a lot of challenges. The swirling changes and developments in teaching and learning all seem promising and yet are still at their infant stages. There is resurgence for Constructivist approaches in the classroom. Howard Gardner contradicts the IQ phenomena with his own findings on Multiple Intelligence. The banking method of education is totally unacceptable to some education circles and yet the new methods bring their own share of confusion. The use of technology is at least one unavoidable reality and twenty years after the introduction of the PC, as many roads have been paved for us to follow, a lot of work still lay ahead. Closing our awareness to the changes that surround us would mean death to us as educators. But diving in the sea of change without a lighthouse or lifesaver at hand would bring about chaos and confusion to those whom we serve.

Integrating technology in Philippine education has taken a lot of turns. There was the initial call for ‘literacy’, which only meant the capacity to use office tools like word processors, spreadsheet, and presentation tools. Others developed specialized skills like programming, use of databases, drawing, CAD, and even robotics. This initial stage required investment in equipment, networking infrastructures, and most of all software licenses that you have to upgrade the following year. This situation not only increased the cost of education but also created an ethical issue of access, which later was associated to the ‘Digital Divide’. Aside from cost, there was also the question of effectiveness, making parents and administrators grow skeptical. The next stage brought technology to the offices and administration and was more successful. Technology was used for the efficient delivery of services like enrolment, grading, accounting, communication, etc.

In the present stage, since technology is here to stay, some educators took a second look at how technology is being used. Instead of technology dictating what they should do, they started telling technology what they wanted to do in teaching core subjects. The technology experts of the school started shifting gears. From being the untouchable nerds in the computer lab, they suddenly found themselves as the assistants of the teachers finding ways to bring technology at the service of learning. There is a change of paradigm for the better.

The paper will present an early work on Laboratory Automation in coordination with David Vernier and the products that came afterwards. This project was the initiative of a teacher in coordination with the Science department and made use of regular correspondence (snail mail) in order to communicate and exchange experiences. The resulting equipments together with other imported ones from Vernier were then used during the regular teaching in the science laboratory. The next experiment highlights a volunteer work with a few Tondo High School students after class. The initial efforts of computer literacy were raised to a different level upon collaborating with other teachers and classrooms in different countries. The collaboration centered on a research-project that centered on SARS. Finally, noteworthy conclusions will be drawn from the experience both on the pedagogical and administrative domains.
The latest catchword in education circles is constructivism. Constructivism draws on the developmental work of Piaget (1977) and Kelly (1991). Piaget asserts that learning occurs by an active construction of meaning rather than being passive recipients. When a new experience runs in conflict with the current way of thinking, a state of disequilibrium is created. We then try to make sense and assimilate this new information into our existing knowledge. Kelly (1991) proposes that we look at the world through mental constructs or patterns, which we create. We develop ways of construing or understanding the world based on our experiences. When we encounter a new experience, we attempt to fit these patterns over the new experience.

While constructivism has also its faults that we will not discuss here, it presents a new model of teaching and learning that places the learner at the center. The educator merely facilitates the learning process. His role is to make the learner an active agent in their learning. An important component of constructivist theory is to focus a child's education on authentic tasks. These are tasks that have "real-world relevance and utility that provide appropriate levels of difficulty or involvement". It would be impossible for us all to become masters of all content areas, so "instruction is anchored in some meaningful, real-world context" (Jonassen, 1991, p. 29).

Mastery of the fundamental ideas of a field involves not only the grasping of general principles, but also the development of an attitude toward learning and inquiry, toward guessing and hunches, toward the possibility of solving problems on one's own ... For if we do nothing else we should somehow give to children (students) a respect for their own powers of thinking, for their power to generate good questions, to come up with interesting informed guesses ... to make ... study more rational, more amenable to the use of mind in the large rather than memorizing. (Bruner, 1960, p.20; 1966, p. 96)

Two of the more popular methods that dwell into real-world contexts are called Discovery Learning and Problem-based Learning. Both are inquiry-based learning method. "There is an intimate and necessary relation between the processes of actual experience and education" wrote Dewey. It also enjoys the support of learning theorists and psychologists Piaget, Bruner, and Papert. Surprisingly, it is only in recent years that these methods are gaining support and extensive research. There is little difference between the two. Both are exposed to solving problems in a way that leads to the construction of the set of truths that are in congruence or an improvement of what society has accepted. Problem-based Learning (PBL) only recommends that the problem be large enough to be handled by collaborative groups and the teacher serves as a facilitator or a resource guide. Thus, an added element of cooperation is necessary with PBL. This method is highly used in medical schools as they study cases.

The skills necessary to solve problems take more than just the acquisition of rules, knowledge, or pre-programmed steps of instructions. One needs to be flexible in their cognitive strategies to accommodate unanticipated situations and come up with meaningful results. Problem solving taught in schools is too controlled with well-defined parameters and even expected outcomes with only one correct answer. Unfortunately, students skilled in this method are not adequately prepared when they
encounter problems in which they need to transfer their learning to new domains, a skill required to function effectively in society (Reich, 1993).

Evolving constructivist perspectives on learning have fueled interest in collaboration and cooperative learning. Constructivists who favor Vygotsky’s theory suggest that social interaction is important for learning because higher mental functions such as reasoning, comprehension, and critical thinking originate in social interactions and are then internalized by individuals. Children can accomplish mental tasks with social support before they can do them alone. Thus cooperative learning provides the social support and scaffolding that students need to move learning forward (Woolfolk, 2001, p.44).

The ability to reformulate and construct new knowledge is within the context of a functioning society. This also highlights the fact that students need to learn to work together or in collaboration with others in order to solve a problem or even invite the whole class to evaluate the outcome of a small-group’s work. Koschmann (1996) defines collaborative learning as a reculturative process that helps students become members of knowledge communities whose common property is different form the common property of the knowledge communities they already belong to.

In the face of all these changes, the challenge for educational technology is to be able to find the right tools that could facilitate this process. How can technology be at the service of the pedagogical style a teacher is employing? The use of new technology should become a tool that is an integral part of the child’s learning process. Technology can be used effectively in many ways. Barr's (1990) five goals essential to meaningful educational reform apply here. He states that learning should be more independent, individualized, interactive, interdisciplinary, and intuitive.

Properties of today’s technology can help achieve and support these goals (Table 1). Promoting a constructivist environment seems to be impossible without technology. According to Mann (1994) students are empowered as they gain access to real data and as they get to solve authentic problems. In such settings, teachers and children become co-learners. “The key to success lies in finding the appropriate points for integrating technology into a new pedagogical practice, so that it supports the deeper, more reflective self-directed activity children must use if they are to be competent adults in the future” (Strommen and Lincoln, 1992, p. 473).

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Technology Tools and Strategies that could be used</th>
</tr>
</thead>
<tbody>
<tr>
<td>Independent</td>
<td>Search engines, Newsgroups, Ask an expert</td>
</tr>
<tr>
<td>Individualized</td>
<td>Tutorial programs, Monitoring of progress through evaluation, Drill and practice</td>
</tr>
<tr>
<td>Interactive</td>
<td>Email, chat, video conference, Forums, bulletin board, Connect w/ other classrooms</td>
</tr>
<tr>
<td>Interdisciplinary</td>
<td>Source of information is not contained to the teacher.</td>
</tr>
<tr>
<td>Intuitive</td>
<td>Collating Information, Presentation tools, Digital recording</td>
</tr>
</tbody>
</table>

Table 1 Technology Tools for Constructivism
Science teaching at Don Bosco College Canlubang has been under the guidance of a pioneer in appropriate technology to demonstrate science. Fr George Schwartz, sdb, a German missionary has dedicated a lifetime of making the teaching of science easier to understand through observable phenomenon that surround us. His dynamism even in his advanced years allowed the school to take an additional step into integrating technology with science as early as 1992.

The experiment started with physics making use of photogates to measure speed and acceleration in the air-track, freely-falling bodies, and rotational speed. Using photogates as a switch and attaching it to a computer’s game-port toggle, a simple program in Basic could know when an object would pass its path and for how long. Photogates consists of an LED on one side and an LDR on the other. They are aligned so that the light from the LED gives a constant supply to the LDR. Once the light between the two is blocked, there will be a change in the LDR resistance that is recorded in the computer as a change in the status of the toggle switch. The length of time that this switch is open or close indicates the length of time the path is blocked. College students who were using it made a lot of progress in the measurements and were able to do twice as many experiments than when just a stopwatch was being used. This simple innovation was patterned after PASCO photogates.

The initial experiments that made use of the photogates were a) study of constant velocity on a level air track; b) freely-falling bodies (picket fence); c) constant acceleration over an inclined plane using a stepping block; and d) collision on an air track. In setting up the experiments, black cardboards with equal measurements or black adhesive tapes are used to block the photogate’s path. On all the experiments mentioned above, one to four photogates are used. An object that will pass through the photogate would have a black cardboard mounted or it. Speed is measured by taking the length of the cardboard over the time it takes to block the photogate. The photogates are mounted on fixed positions in the plane or along the air track and the speed of the objects at varying points are taken to identify acceleration or constant velocity. In measuring freely-falling bodies, a picket fence dropped across the path of a photogate. A picket fence in made of transparent material (fiber glass or plastic) where equally distanced black tape or paint is placed. As the fence falls, the speed of each blocked path passing through the photogate will vary (increasing) and the change in velocity for each will be the measure of acceleration. Later innovations that were imported made use of a pulley with equidistant spokes. The pulley is mounted such that the spokes pass through a photogate giving a similar reaction to the picket fence.

David Vernier and his colleagues were doing similar innovation for the science laboratory. Their products were later known as Vernier products. The group worked in an open research environment that fostered collaboration among the teachers and researchers. Initially, even the full specifications of the devices were open to all so that others can replicate it with the available parts in their location. With the help of Caliper, a quarterly newsletter published by Vernier, teachers get to exchange ideas in using the devices for different school experiments. On account of this open research, Don Bosco College shifted to Vernier products. David and his wife Christine Vernier helped the school on a personal capacity to purchase some of the equipments and keep the school informed of their ongoing research through regular
correspondence. The equipments later increased to address laboratory needs of Chemistry with the temperature probe and pH meters, and Biology as well with Oxygen, Carbon Dioxide, and other sensors. As the equipment advanced and the company shifted into a full commercial enterprise, schools like Tufts University published laboratory manuals that are integrated in their curriculum (in the U.S.).

In the experience of Don Bosco, the use of the sensors was always accompanied with the use of the PC. Texas Instruments’ Calculators, while also an option, was not explored for use. The laboratory could handle a maximum 8 experiments being setup simultaneously (depending on the equipments used). Of the 8 experiments up to 4 would be using the sensors and a computer unit. The results were recorded and compared later during the lecture or at the beginning of the next laboratory class. The small class size in college was also supplemental in its proper use due to better management. Regularity of use made the students more comfortable in setting it up. What is most encouraging is that students began using the tool for other experiments like measuring a pendulum, which the teacher did not plan. Experiment results were easily graphed, and conclusions were made using both individual observations and comparing with the other experiments. Compared to the experiments without the sensors, it is far easier to redo the experiments once the sensors are setup. This saves time and introduces accuracy in the measurements. As the school started its own pilot high school in 1998, handouts for the use of the equipment and its integration in the high school science laboratory was also prepared. (Refer to the Appendix for sampler laboratory handouts from Tufts University and from Vernier)

College teachers and some students began developing handouts for the use of the equipments in the pilot High School, which began in 1998. For the first four years, there was hesitancy and failure in the use of the equipment for High School and remained only in college. The handouts were set aside and the equipments were used sparingly and only during teacher demonstrations. The failure of its use could be attributed to several factors. The first factor is administrative support. The pilot high school was just beginning and the acting principal took a more conservative stance in implementing the curriculum. The second factor is teacher training and preparation. Since the teachers were newly hired for the opening of the pilot school and it still had to go through the 4-year cycle before it could stabilize, the new teachers were unfamiliar with the technology and were far too busy with the day-to-day activities. Training the teachers was also not forthcoming so the use of the technology was only upon their approval. If they do agree, another teacher who knows how to use the equipment will assist them. The third factor is time. Teachers spend 30 hours inside the classroom and the rest are dedicated to preparing new lesson plans and checking papers. The introduction of the Revised Basic Education Curriculum also brought training for technology in the lower end of the priorities.

The college maintained a steady use of technology in the laboratory for the Physics and Chemistry classes as the first few years in the pilot high school got stalled. The transfer of the teacher who started the innovations and the deteriorating health of Fr. George also stalled further developments of equipments and collaboration with teachers outside the school. In the past two years, the pilot high school slowly catches up in using technology in the science laboratory. During this time, the school formed a team called TechForce. The team is composed of teachers from college and high school plus a few student volunteers that were more technology savvy than the rest.
The role of the team was to conduct regular training (once-a-week) for the teachers in the use of technology. Many of the teachers are computer literate but they lack good examples to pattern from in integrating technology. The training also becomes an avenue to discuss and present ideas. The process is slow but it considers the limited resources available to the school and places premium on the long-term effects of the in-house training.

Integrating Technology in the Core Subjects

Genetics Computer Institute, through its TIPS program assists approximately 50 schools nationwide to implement their own technology integration in elementary and High School. Among others, the company provides training to teachers, manuals for students, and a standardized curriculum that would allow students who finish the whole program to take an international certification exam in information technology. The additional subject, which makes use of the time for technology class, provides computer literacy and further develops special computer skills. Some of the topics covered include webpage development, programming, photo editing, advanced wordprocessing, database programming and spreadsheet for business applications.

In the school year 2003-2004, responding to the changing curriculum, Genetics started to develop lesson plans for core subjects. These lesson plans would allow the students and teachers to make use of technology in order to meet the learning objectives of the subject. World History, Algebra, and General Science were selected as the initial subjects for development. The table below shows forms of integration that makes use of the constructivist model of learning.

<table>
<thead>
<tr>
<th>Subject</th>
<th>Teacher’s option</th>
<th>Student activity</th>
<th>Other formats</th>
</tr>
</thead>
<tbody>
<tr>
<td>Algebra</td>
<td>Presentation of equations using graphs in a spreadsheet.</td>
<td>Drill and practice; further deepening on behavior of equations.</td>
<td>Use of Algebra programs with practice exams.</td>
</tr>
<tr>
<td>World History</td>
<td>Research homework of topics, cultures, music, etc, using cooperative learning. Connect with other classrooms in the country being studied.</td>
<td>Presentation of collated materials in various forms using a webpage, powerpoint, or other tools. (Multiple Intelligence)</td>
<td>Skits or musical compositions could be done outside class, recorded and digitized and included in the file.</td>
</tr>
<tr>
<td>General Science</td>
<td>Presentation of Video clips, use of Science Software in the classroom, Inviting an expert in class through live chat or email.</td>
<td>Recording of observations using digital equipments. Using spreadsheet graphs and wordprocessors in submitting reports.</td>
<td>Long term observations using laboratory automation equipment. In-depth research over the internet.</td>
</tr>
</tbody>
</table>

Table 2 Application of Technology

Unfortunately, the pilot testing and implementation of the lesson plans in a regular high school was not able to take place due to some problems encountered. The following is a list of problems that prevented the project from taking off immediately in the selected pilot school.
Administrative Concerns:
- Introducing the lesson plan will disrupt the cycle of lessons. The school still needs to contemplate and decide on fully shifting to the Revised Basic Education Curriculum.
- Time and coordination between subject teachers and the computer teachers. Should the computer teachers still be classified as full teachers or just assistants?
- Reaction of Parents to the school. Full approval of the PTA must be sought before it can be implemented in a regular private high school.
- What happens to the former computer books that the school was using?

Implementation Concerns:
- The teachers in the school, having taught their subject for a long time already, were hesitant to change. The new teachers were welcoming but the process needs to get the approval of the others. Some of the teachers of the core subjects still need computer literacy training.
- The majority of the teachers were using an objectivist approach to education. Shifting them to constructivist and alternative forms of assessment was too sudden a change.
- High Resistance on the part of the school can be attributed to the fact that there was little participation of the teachers when the lesson plans were being constructed. The school follows a cycle of preparations and Genetics must respect the cycle.

Collaborative Research Project

Tondo High School is a public high school situated at Bo Magsaysay, Tondo Manila. Its population is approximately 6000 with Ms. Winifreda Lagman as principal. Many among these students go to Don Bosco Youth Center and the Jose Reyes Memorial Library, within Don Bosco compound after class hours. Together with students coming from other schools, the students engage themselves in various activities like sports, clubs, study groups, and others use the place as a venue to practice or assemble for a school project or just waste time.

The experiment began with a select group of 2nd year students (SY 2002-2003) coming from section 2 (Bravery) of Tondo High School. The selection process was based on their volition in coming to the Jose Reyes Memorial Library to study at a regular basis. What initially brought them there were their assignments in History. Around 20 were selected and about 10 would be consistent enough to be present for at least twice a week engaging their selves with the experiment. They are not made aware that an experiment was in progress. The group was homogenous and was friends with one another.

The first part of the program was to establish computer literacy. Basic skills was taught like word processing, printing, use of the Internet and how to do an efficient search, use of supplemental CDs like Britannica and other tutorial softwares. One of the primary skills they had to develop was to distinguish between the information that the Internet can provide versus those that they can get from the books. They also learned about the limitations of the Internet in searching for some types of
information (i.e. Filipino literary works). Each one made his/her own email address using ePals.com. This was used for internal communications and other recreational activities like sending egreetings. The initial objective is to make them comfortable with the tools.

The next phase of the project began October of 2002. The participants were Gesa Korde of Koblenzerstrabe school, Bremen, Germany, Joyce Lee of Canberra Secondary School, Singapore, and Maruyama Toshiyuki of Ikegami Junior High School, Yokosuka, Kanagawa, Japan. The three participants are English teachers in their respective schools handling a group of 12-15 year olds. The average size of the groups is 14. The students of Tondo High school connected with the three classrooms through email as a supplemental activity in their study of English. The teachers paired their students with the local students and they were to exchange letters with each other during the whole season for at least once a week. The local students were first asked to write the letters by hand (since they had to fall in line to use only 2 computers). Then they were to ask someone in the group to check the spelling and grammar. They then wrote it in a word processor with grammar and spelling checker active. Chatting was not used as an option.

The topic for the correspondence and exchange was uncontrolled. The students can write whatever topic they please but they had to write once a week. There was only a total of 6 letter exchanges between the Germany, 8 letters with Singapore and 2 letters with Japan. Letters done after the season was not counted. The topics of the discussion varied from getting-to-know-you, something about your town, sending pictures, help me with my History assignment, and what is your favorite music. One note-worthy incident was when the local students got an assignment to submit/compose a unit of kabuki. Their partners in Japan were able to give a lot of input. The exchange lasted for one full season. During the winter break, the German students stopped writing. A few of the Singapore students continued to write beyond the designated period.

During this project, some observable behavioral changes took place among the local students. The students had improved sentence construction in terms of subject-verb agreement. The use of alternative vocabulary through a thesaurus was also done. The local students were very motivated to correspond to their counter parts. Mr. Toshiyuki reported that their students were hesitant in expressing themselves in English, which caused a very low exchange. Ms. Korde of Germany reported that there were several occasions when they encountered technical problems with their computer laboratory, which prevented them from writing for that week. The teacher of Singapore, Ms. Lee, did not provide any report about her students.

By the following school year, Ms. Joyce Lee proposed to extend the project into a collaborative research project in the wake of the SARS outbreak. The project would be participated by 5 schools in 5 different countries. The participating schools were Perth Amboy Tech HS, USA, Caritas Lok Yi School, Hong Kong, Tondo HS, Manila, Changi Women Prison, Singapore, Canberra Secondary School Singapore. The objective of the project was to raise the awareness about SARS and how to prevent it. The groups were to investigate on SARS. What is SARS; how can it be prevented; what are the cures; and what are the steps the government is making? The project lasted for 5 months.
Implementing the project required collaborative efforts from group members. The project came at a time when the students also had a lot of requirements and group practices for their subjects. The project remained as an additional load to them. The students divided the research and scheduled themselves in using the Internet. Since SARS is rather new and there is little information about it, the sources were quite limited. They were trying to sift through the news articles, which is factual. The information drive and cleanliness campaign of the Philippine government plus the information on SARS recorded in the government website was most helpful to them. They then met once every fortnight in order to put together and collate the materials they had. The discussed their findings on each of the research questions. Exchange of email with Singapore allowed them to get a different perspective and additional information on the matter. Towards the end of the research, they decided to use visual art (drawing and coloring) as an expression of their findings plus their own personal commitment to the crisis. The result was digitized and submitted to Canberra, Singapore.

Project website: [http://www.canberrasec.net/~joycelm.css/sarsglobalproject/](http://www.canberrasec.net/~joycelm.css/sarsglobalproject/)

Summary and Conclusions

Use of technology in order to attain a rich experience of learning is essential. There are a good many examples to pattern our actions from. But there are also pitfalls that beset us once in a while. Some lessons that can be learnt from this experience are the following:

1. Teachers must be valued and respected. No matter how urgent change may be, we can only go as fast as the teacher in the classroom. To teach authentic collaboration, we should practice it first. The ground is rich for discovery. Teachers should challenge themselves to move away from their comfort zones.

2. Laboratory Automation works. Placing accurate inexpensive tools at the disposal of students is a roadmap towards active learning. Science learning without the elements of discovery, accuracy in observation, and analysis tools, will but remain an exercise of memorization.

3. Presentation Tools are windows to how our students think. Presentations can be multi-faceted and can even show the different intelligences of our students. The challenge for us would be to develop authentic assessments or rubrics in order to make a better evaluation.

4. Internet is a rich source of information. While search engines do help us a lot to make better preparation, we need to train the students to be discerning of the information they acquire and to respect the work of others through proper citations.

5. The world is my classroom. A teacher must look beyond the walls of the school. There are many classrooms we can connect with. There are many teachers who face the same situation. But most of all there is an available technology to bring them together, working hand-in-hand, striving and succeeding. A teacher should share their success and failures.
References


Appendix of Lessons

Determining the Concentration of a Solution: Beer’s Law

Picket Fence

Falling objects

Collision with PASCO

An issue of The Caliper

SARS Project website: http://www.canberrasec.net/~joycelm.css/sarsglobalproject/