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Reflective Practice Series: The Early Journey with Technology in Education

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Introduction

In this paper I trace my personal instructional journey through key instructional-learning events in my own career as a student, teacher, and professor. It is by no means inclusive of all historical instructional events of the previous decades, but only those which had a profound impact on my career development. In essence, it is the intersection of aspects of my life course and instructional science. The life course perspective elaborates the importance of time, context, process, and meaning on human development (Arber & Evandrou, 1993). Reflective practice is not only looking back on past actions and events, but is taking a conscious look at emotions, experiences, actions, and responses, and using that information to add to his or her existing knowledge base and reach a higher level of understanding (Paterson & Chapman, 2013). All encompassing in my journey is the use of some type of "technology." Technology evolves sometimes very slowly and at other times exponentially. But the definition technology is not just using modern computers or e-devices.

> **Technology** ("science of craft", from Greek τέχνη, *techne*, "art, skill, cunning of hand"; and -λογία, *-logia*[3]) is the collection of techniques, skills, methods and processes used in the production of goods or services or in the accomplishment of objectives, such as scientific investigation. Technology can be the knowledge of techniques, processes, etc. or it can be embedded in machines, computers, devices and factories, which can be operated by individuals without detailed knowledge of the workings of such things. (Technology, 2016).

Physics and FOCAL

In the late 1960s as an undergraduate mathematics major while studying computer science and physics I was subjected to problem-based learning. Problem-based learning or PBL "is a student-centered pedagogy in which students learn about a subject through the experience of solving an open-ended problem. Students learn both thinking strategies and domain knowledge (Problem-based learning, 2016). We were upper level students who possessed adequate base-line knowledge in mathematics, computer science, and we were in the process of learning Physics. Our charge by our physics professor was to use a new FOCAL-language based upon a PDP-8 interactive computer to solve physics laboratory problems though simulation on the computer. The PDP-8 was a computer donation-grant from Digital Equipment Corporation (DEC, 2016). At the time, DEC was a large computer corporation with the corporate headquarters in Maynard, Massachusetts. FOCAL stands for **F**ormulating On-Line Calculations in **A**lgebraic **L**anguage and at the time required no operating system, it was a complete programming environment similar to BASIC (FOCAL, 2016).

Our real tasks were to translate Physics formulas and problems into the FOCAL programming language (it wasn't easy). We had one manual on the FOCAL language, four of us in our group, and a physics textbook. We established what we thought we knew, what we needed to do (or know), and tried to get new information. Our instructor did not know how to program the computer, but was very well versed in physics. He supported us, gave us physics advice, reviewed (and graded) our computer printouts. Looking back, I guess we learned how to problem analyze, communicate (no Smartphones back then), collaborate, and direct our own learning. Memory (ROM) of the computer was in the 4K to 8K range, one problem simulation would take days to run, and then it might be wrong... and need corrective action, more days, time, etc. You must remember we had an adequate baseline knowledge to begin with, mathematics/computer science, physics was the challenge along with learning a brand new programming language.

This was really my first academic experience with problem-based learning, although the instructor never mentioned it as such. Even though this experience is well over 45 years old, it still has influenced my own teaching, training, and use of technology decades later. We did succeed in our work and were also successful in the physics course. *We learned how to be self-directed learners and what we needed know.*

I also think we developed a higher level of understanding and comprehension in both applied computer science and physics, but I also saw the value of computer simulation at the same time. We were goal driven (by due dates) and collaborated – communicated within our team. We were highly motivated and challenged to "get it right" and we learned independently. During that semester physics was like a second job, we spent an enormous amount of time on the computer reading yards and yards of rolled yellow paper printouts and graphs with asterisks *******.

The Open Classroom

In the early 1970s I found myself as a first year teacher in a new high school with the "open classroom" concept. Prior to the school's opening, the faculty underwent intensive training and instruction on individualized learning and the "open" school concept. Much of the actual practice of individualized learning was theoretical at the time with little empirical research to support or not support its use. "Individualized instruction consists of any steps in planning and conducting programs of studies and lessons that suit them to individual student's learning needs, learning readiness, and learner characteristics, or learning style" (Heathers, 1977). What the instructors were charged to do was to implement individualized instructional methods for every student they taught. With well over 125 students in five classes, this was no easy task. I was housed in a mathematics center with the open concept, no walls, just several hundred students assigned to the center at a given time. The acoustics were not bad, special construction of the ceiling tiles absorbed sound fairly well. There were some movable partitions where we set up "mini" lectures on various math topics. Students could self – select to attend or not attend. What was a problem at times was discipline..., adolescents with "freedom" that lacked the maturity...became chronic discipline problems, and quite frankly did not perform well in the center.

LAPS, Unipacs, and Programmed Learning

A Learning Activity Package (LAP) is a program of study or lesson in a printed package form that covers a particular aspect of a subject. The LAP follows a logical sequence of instructional objectives and learning activities which implement these objectives. The student, with his individual LAP, is free to proceed through the objectives and activities at his own pace (Duke, 1973). In my practice, I had a few sample LAPs, but none that I could readily use for my own classes. The learning activities had to be self contained (within the LAP) or available for immediate use when the student reached a related instructional objective. Instructional resources for this time period were film strips, audio recording (tapes and records), books, magazines, overhead transparencies, and maybe the teacher (if they were not helping someone else). The technology was really not there to support this process. These LAPS were bound paper copies and had to be printed, stored, and cataloged. Needless to say my first year of teaching was overwhelming to say the least, I could not keep up with the students, the demand exceeded the supply of LAPS.

We also had at our disposal Unipacs which were very similar to LAPS, except they were more self-contained and usually revolved around one lesson or topic. A Unipac is a self-contained set of teaching learning materials designed to teach a single topic. It is normally structured for individual and independent use with provisions developed for interaction with other learners and/or teachers as needed. It lends in the development of a continuous progress school program (Guidebook, 1971). Again in theory a great idea, but in practice difficulties similar to the LAPS,and because of the limited focus (topical) "more" were needed. All these materials had to be indexed, cataloged, and made readily available. Students in some cases could not take out the materials from the center, so how do they do their "homework" and work at their own rate? This is only one example of the many difficulties we (the teaching staff) had in practice. After a year of struggle, the faculty revolted in a staff meeting and appealed to the superintendent of schools to "listen."

The faculty said that textbooks could do a much better job than LAPS or Unipacs as teachers were not trained to be professional writers or publishers. Even with intensive training we (the faculty) could not keep up with the student demand for materials to accomplish instructional objectives. Hence, we then moved to programmed learning textbooks. This move saved my instructional life in that school and allowed me to assist, clarify, and teach the students the course content. Programmed instruction textbooks were divided into frames. Each frame had instruction, some examples/samples, a question, a a required student response, and immediate feedback on the response (Dempsey & Sales, 1993). I used Addison-Wesley Publication ™ programmed textbooks in Algebra, Advanced Algebra, and Trigonometry to name a few. The books were professionally designed and treated the course content exceedingly well. There were numerous self tests, tests, unit tests, and so forth. The basic structure was: a pre-test (what the students know now)=>immediate feedback=>prescribed learning activities based upon pretest=>post-test. They were easily corrected in class by me and recorded (pencil and paper). Some of the assessments had various forms A,B,C…etc., where the content validity was similar, but the actual questions were different. This helped with cheating and academic dishonesty. The students would hold a card over the answer to a frame, first answer the question, and then compare their answer with the answer given. If they were correct they move to the next frame, if not correct, go back and find out why (and/or ask the teacher). For the most part the students liked this type of instruction, better students could not get enough, so you had to find ways to challenge them beyond the programmed instructional text. All was not good however, there were some students that were bored, possibly had undisclosed learning disabilities, and did not perform well. They were not engaged with the course content.

Bloom's Taxonomy

Throughout all my educational endeavors, both as a student and instructor, Bloom's Taxonomy of Educational Objectives has served well (Bloom, Engelhert, Furst, Hill, & Krathwohl, 1956). The original research classified educational learning objectives into three domains: cognitive, psycho-motor, and affective. Most of my experience has been with the cognitive domain (mental skills, knowledge) used for analyzing concepts, processes, procedures, and principles. There are six hierarchical categories with the cognitive domain: knowledge, comprehension, application, analysis, synthesis, and evaluation. Within each category there are verbs that represent that category. What do you want the learner to know, and how can the "technologies" aid in its accomplishment? These can be used in a variety of ways, you can develop new course objectives with the use of "technology" for example. Krathwohl (2002) revised the original categories into: remembering, understanding, applying, analyzing, evaluating, and creating. According to the author, the changes reflect more active forms of thinking and instead of nouns as descriptors, verbs are used.

There is no one way to use Bloom's Taxonomy. At the college level, the lower level courses sometimes focus on knowledge and comprehension with some application. Upper level courses will usually have the addition of more analysis (for example, case studies). Synthesis really refers to asking new questions as a result of a thorough understanding, analysis, and application of the topic under study. It is also self-defining new problems to be undertaken, and a thorough knowledge of existing literature on the topic. Evaluation is determining the value or worth of something. Expert and peer review of materials, performances, and valued outcomes are sometimes evaluated. You can concentrate your efforts at one level, across several, and/or use all six. I still believe that a "capstone" experience such as a thesis, dissertation, and/or end study paper are all invaluable in learning because they work rigorously across all six categories.

Lessons Learned

As previously mentioned, technology is the "science of craft" which can include a collection of techniques, skills, and methods to accomplish objectives and/or scientific investigation (Technology, 2016). From the early experiences here are some of the notable "technology" applications:

Problem orientation – challenging problems which might include research and new knowledge acquisition.

Projects – projects which involve application of new knowledge and skill sets (individual or small group.

Collaboration - learners should collaborate on instructional objectives, i.e., what is required and (small groups) the course of action to be taken.

Interaction – people to people, people with e-tools and all existing combinations. More interaction leads usually to higher involvement and higher performance.

Simulation - this can be done with various e-device (computers, for example), but even role playing is valuable.

Published Instructional Materials - "Do not re-invent the wheel", use what is professionally produced (however, you must carefully screen the materials).

Assessment – drill, practice, and assess frequently for short duration, but make sure "things" are correct.

Bloom's Taxonomy – The "guiding light" for many educational processes, design and develop new learning experiences.

Conclusions

Nearly twenty-five years later, Kearsley and Schneiderman (1999) proposed a theory of engagement where learning activities have three components: (1) occur is a group context, (2) are project based, and (3) have an authentic (or outside) focus. The theory is summarized by the terms: relate (emphasizes team work, create (creativity and purpose), and donate (usefulness of the outcome). So inductively, many years earlier, my own work and research supports the Kearsley and Schneiderman Theory. Other than the FOCAL/physics experience, much of my environment was at most elementary forms of technology. However, their theory states that *technology* can facilitate engagement in ways which are difficult to achieve otherwise. In my early instructional efforts, the technology was not developed enough to be of practical value in the majority of educational applications. The development time and effort was very labor intensive and in some cases overwhelming.

In part two of my journey I will discuss the evolution of educational technology over the last several decades. Educational technology is the effective use of technological tools for learning (Educational Technology, 2016). It can include many forms of media such as: audio, visual, text, images, animation, streaming video, video-conferencing, satellite transmissions, CD-ROM, and various ICTs. Advances in technology and specifically in educational technology have now made possible almost a complete simulation of an on the ground in the classroom college course.

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