Beyond egg dropping and spaghetti bridges

Fred Martin’s Robot Competition and new approaches for Science and Technology learning

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Educators have been writing about changes in the schooling system for decades now. Seymour Papert and Paulo Freire are probably the two most well known intellectuals that, among many others, started pointing out the contradictions of the educational systems all over the world.

For decades, they struggled to convince governments, schools, corporations, parents and teachers that new approaches should be put into practice urgently. Although some changes were observed in some locations, the general outcome is that the system refused to transform itself.

That is, in fact, a natural behavior of any system: survival and reproduction. Both Papert and Freire observed that the schooling system lies inside a greater one, and is surrounded by many other systems. Although these concepts seem obvious, it is surprising to realize how ignored they are in most of the projects that promote integration of Information Technology (IT) and education.

Some of these projects try to use IT as a teaching tool: multimedia presentations, simulations or educational information databases. Needless to say, this approach has many limitations:

“Better learning will not come from finding better ways for the teacher to instruct but from giving the learner better opportunities to construct.” (Papert, 1990, apud Shaw [1])

Another group of projects involve distance learning (recently using also internet technology), with misconceptions as “cost reduction” (the cost is similar to presental courses) [3] or “improved interaction” (interactivity with a machine cannot simply replace human interaction) [4].

A third approach is Constructionism, examining the dialectic process of internalization and externalization and the construction of concrete and/or shareable entities during the learning process.

Most of the constructionist projects are aimed at young children. Even in the event of a complete success of these projects in elementary and high school, what happens when these supposedly highly creative, autonomous and intellectually joyful teenage-learners reach university, in Science and Engineering courses?
Some argue that university is the place to learn the “deep” math, the “serious” physics, and that the playful days of Constructionism should be forgotten. One argument is that there is no way to learn differential equations or Fourier series without classical instruction and exams.

What could be the reason for the overwhelming majority of the constructionist projects to ignore higher education students? Maybe it seems more difficult to build activities about quantum physics than about elementary arithmetic. Or maybe grown-up students don’t need “playful” activities anymore: they are old enough to learn in the traditional way.

Fred Martin does not think so. His brilliant PhD thesis is an important piece of evidence of the feasibility of applying constructionist ideas in the higher education setting.

In his introduction, Martin describes the changes that Engineering education went through after the Second World War, and debate between teachers that wanted more practical content versus the supporters of abstract mathematics.

He points out three very important issues:

- **Design is a rich activity:** refusing the view of design as just a “playful” and not sophisticated activity, Martin (mentioning Schön and Simon) emphasizes it as an important activity for at least two reasons: it could be a formal process and be a collective activity.

- **Design generates new ideas** through many non-intended actions that end up by being interesting solutions. “Engineering is always a contingent process” – it cannot be summarized in a block diagram. [2]

- **Design allows other epistemological approaches** to take place (planners vs. bricoleurs, as in the famous Turkle and Papert study, Epistemological Pluralism, apud Martin [2]).

Although present in Martin’s text, it should be interesting to understand the devaluation of design as a university activity in the historical context. Several factors have to be taken into consideration in this analysis, but certainly two are preponderant: social division of work and the role of University in the post-World War II context. The first factor is certainly not new: manual work, mainly since the industrial revolution, has been regarded as inferior to intel-
lectual work. Rather than a natural process, it happened in a social class context as a result of a power structure. Clearly, intellectual work, information and planning imply power, and a highly specialized and mechanical work, in which the worker do not see the result of his effort, imply submission. As a result, engineering has been gradually disconnected from the bricolage experience (in fact, its origins), and engineers have been gradually promoted to a very different social status as the technician or the manual worker. In other words, who thinks also commands, and the actual manual work is at the end of the production chain and the rewarding scale.

The role of university has also undergone changes in the last 50 years, inside society and the educational system. More and more demands are made to the higher education system, and at the same time, interestingly, state funding has diminished.

Also, as stated by the Portuguese sociologist Boaventura Souza:

"Foucault is certainly right when denouncing the excess of social control produced by the disciplinary power and by the technique-scientific normatization [...] as to maximize its social usefulness and to reduce [...] at the lowest cost, its political potential [...] The hyper-trophy of the cognitive-instrumental rationality resulted in the transformation of modern science through the progressive hegemony of the positivist epistemologies, a transformation that, if not totally due to the conversion of Science into a productive force in Capitalism, had with it very strong similarities." [5]

Fred Martin makes a very important point, in the introduction of his thesis, when comparing structured and unstructured activities. This is an issue that is always reminded to discredit (unfairly) design educational environments with more personal freedom: the notion that freedom equals lack of structure. Martin states that it is just not the case:

“The Robot Design project [...] has its own consistent internal structure that specifically allows for learning to happen” [2]

One of the most interesting conclusions of his work is that the shock between the preliminary mental models and the actual performance of the robot was a very intensive educational experience. The design activity puts our theories to a complex test: reality. That contrasts very much with the classical academic view of Science as a clean and polished construct. The final conclusions of a
scientific research often hide the path to them, preventing students of realizing how complex and subjective the scientific adventure can be.

The logic and motivation of the formal research activity is not necessarily the same as the learning process. Research and researchers, as any other professional activity, have their jargon, internal competition and status, aesthetics concepts etc. Often, a teacher’s teaching style depends much more on his/her relationship to pairs and to the everyday professional. In other words, the language and the style of the formal research activity may not seem engaging for students, not because they are not interesting, but because they are a wrong entry point. Martin’s work is, on the other hand, an excellent entry point: the design activity can lead to formal science learning, not because one is superior than the other, but just because they complement each other.

Formal science and its own aesthetics is not accessible at the first contact, as the very strict formalism of classical music may not seem interesting to learn before listening to a Mozart symphony or a Bach cantata.

The mistake is to think that design is just an entry point, and not an integrated experience in the Engineering course, as Martin also states. In fact, the interaction of design, instruction and research would be an excellent way of reformulating higher education courses.

Martin also admits that this is a necessary future development of his work: integrating it into the regular courses.

Some other issues can be considered: it would be interesting to connect the robot design to everyday life, not only from a personal point of view but rather connecting it to a community need. Although many of the projects developed by the students were actually brilliant, they could have a more definite collective usefulness after the activity, which will transform certainly the initial conception of them. That could open much more perspectives for the students, as the study of the social life in communities and the notion of social interference through technology.

Fred Martin also concludes that he did not observe much reflection after the projects, and that could also be addressed with a different motivation, also reminding Paulo Freire’s worry about a close relationship between the learner’s world and the content.
On the other hand, everyday life and its needs may not be such a creative ground for innovative ideas, if we consider that often the robots that are created in design activities do not have a specific problem to solve, but are rather an exercise of imagination.

However, as the main claim of Construtionism is that learning takes place by internalization/externalization as well as building real and/or shareable objects, it seems useful to connect these objects to real life, not in a formal and conventional way, but rather thinking about artifacts that could transform everyday life, rather that incrementally change it. Fred Martin’s thesis is a giant steps towards a methodology, and not only a method or a particular activity. His careful approach allows us to extend his work for other settings and areas of knowledge. What is more, he actually “constructed” his own meta-object: the IAP course.

Having studied himself Engineering, Fred probably realized that most of the people who seek this career are not after mathematics formulas. They are after a dream; they are in a quest to build, to construct, and to make objects that can interfere in the world. Mathematics is just a tool to achieve this, and not an end in itself. By forcing students to forget the fascination of design for many years (and maybe have some design activity towards the end of the course, when they supposedly “know enough” to build), we are suppressing a creative force that may never come up again.

Remembering Papert, Freire, Vgotski and Aaron, it not difficult to realize why engineering courses (which are closely related to industry and to the industrial paradigm) are so arid, so hierarchical, so emotionally frustrating for many students.

In the words of Rubem Alves, a famous Brazilian scientist and educator:

I would ask if the failure of our educational institutions and educational practices is not due to the resistance of the salvage that maintains us rebels, and refuses to accept the deformation of the body.

[6]
References


