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Research Paper

Some Considerations on Training of Innovation Ability and Reform of Education

Run Ze Chi • Guo Chun Wan • Mei Song Tong

Department of Electronic Science and Technology, Tongji University, Shanghai 201804, China

*Corresponding author. E-mail: mstong@tongji.edu.cn.

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Abstract. This paper involves the experience and thoughts of the writer, who is a first-year graduate student, about the education he received. Thoughts and suggestions are presented in this paper about the life of higher education and some improvements that can be made for the professors and teachers.

Keywords*:* high-level education, teaching, communication, collaboration.

INTRODUCTION

The education of higher-educated people is a vastly different matter from the education of high school, or primary school students. On one hand, the people receiving the higher-level education may have a very deep understanding in one niche area, whereas in other areas, sometimes even that area is superficial to most of common people, they can be ignorant. On the other hand, the people who are receiving such level of education are typically mature enough to have the ability of self-education, this is to say, even they can be ignorant on the class, they are able to look up the necessary resources to help themselves to catch up. This situation leaves the educator in a situation where they want to teach in a more sophisticated way, yet the quality of their students does not allow them, or it is not necessary for them to do so (You *et al*., 2005).

The experience of my education is the classic story. I have received many kinds of education, going from the teacher who is strict and clear to even the most niche point to the professor who just tip the subtlest points and tricks. Both experiences are neither comfortable nor satisfying to me. The detail-driven teacher will waste a ton of time, blabbering about the trivial points that won't have any impact on the thing you are doing. However, the master-level professing is even painful because of I usually lack the necessary knowledge needed for the understanding of the tricks and subtle points, this case will also be a waste of time because in the end, there won't be much new knowledge digested.

ABOUT THE WAY OF CONVEYING KNOWLEDGE

Project is the king of understanding

The most effective way of understanding the points, from my experience, is through the process of doing a project. Throughout a class, which has lots of important points, teachers will emphasize these points by distributing projects. The process of doing the project is the process of using and understanding the knowledge points and their necessities. The projects that I did is still carved in my brain even the class had long ended. The other point that I believe that the project-driven style of teaching is great is that such kind of class also emphasize the importance of communicating. The ability of communication is especially important because that problems induced by an unclear dictation will lead to misunderstanding between the group mates, which may lead to the undesired result. One

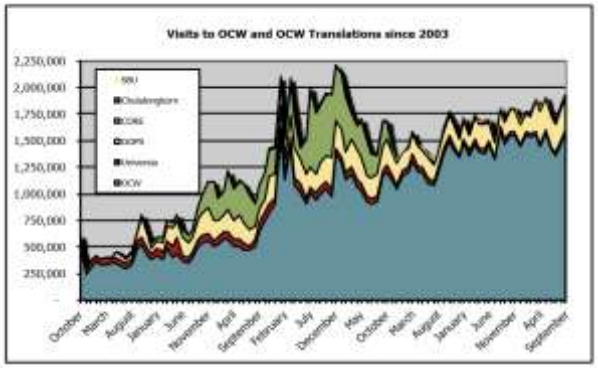

Figure 1. Visits of MIT Open Course Ware since 2003 (Source: MIT OCW official site)

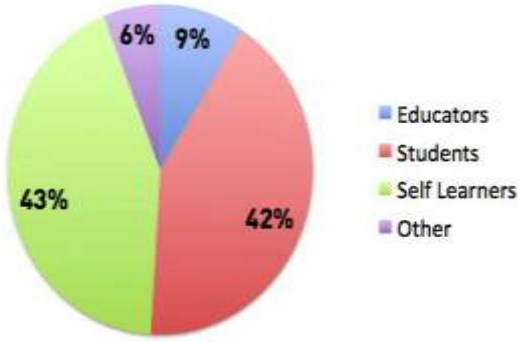

Figure 2. Percentage of people using OCW

experience of mine is a vivid example of this: the project of one class involve people doing the analog circuit, the digital calibration of the analog circuit, and the people who use the MATLAB software to verify the algorithm works fine and converges. This combination is actually very common in company. Yet because we all just have a small understanding of our own area, there are not much communication between. The accident happens when we realize the project where we put together our own module is not responding in the expected way. The reason is that the data structure that MATLAB uses is different form the data structure that the hardware. The actual hardware has the higher bits stored at the larger number in the output array, yet in MATLAB, array starts from 1. This bug is extremely subtle and it makes the chip behave in the mostly bizarre way. Resulting the communicating between the analog and digital part of the chip is reverse-coded. The point that I want to make from this example is that sometimes bugs can appear from the misunderstanding of the communication between people, and projects make us realize it and enhance our ability of communication as well as engineering.

Passion is way underrated and hard to find

Another point that I think lots of people forget is that they need to feel that the work that they are working on is fancy and important. Most of the students in graduate school are working on the projects of their mentor professors, yet most of them are struggling to glue everything they know together, anything that works will do. Such approach will only result on something that is functional or more precisely, workable. People are becoming the 'package-grabbers', without doing anything that is not being done by other people. Yet if people are loving the stuff they are working on, and believing that they are working on the future, they probably will spend their nights in the labs, sleeping in front of their computers, because working on futuristic technologies is extremely fun, just as Elon Musk once said. Indeed, just as the most experienced professors claimed: you need to have passion on the stuff you are working on. Thus, the second point I want to make is that it is both challenging and important for the educator or mentor professors to arouse the passion about the subject they are working on.

There is just no stop of self-education

The third point that I experienced during the process of studying is that it is necessary for people to have an extremely strong ability of self-education. Because as the way of education go on and on, students will realize that the actual world is far more bizarre and confusing than they thought. Just as once I talked with a doctor in the same lab, doing the ultra-high-speed design need lots of knowledge about radio frequency circuit design, as the speed goes higher, we are now even surpassing the radio frequency range, thus it is electromagnetic wave and field related knowledge that is needed to assist the circuit and layout design. During this process, the education will largely become horrendously deep, thus it is said in the industry that one will keep learning, even long after graduation from school. This point is presented to emphasize the importance of inspiring the notion of self-education for the educator. There is always something you don't know that is needed in your design, and a good educator will make students a great self-educator.

Purpose of self-education for all kinds of people

(Source: MIT OCW official site)

There is a saying: the knowledge of people is always wrong, every realization, every correction will simply lead us a little closer to the truth, but, yes, we are still wrong. It is typical for people to think that an easy fix will do the trick, yet the fact is that after the fix, there is still a ton of undiscovered bugs and glitches, people just didn't find it or not

Table 1. Purpose of self-education for all kinds of people

Educators	Improve personal knowledge	31%
	Learn new teaching methods	23%
	Find reference material	20%
	Develop curriculum	26%
Students	Enhance personal knowledge	46%
	Completement a course	54%
Self-Learners	Explore other areas	40%
	Review basic concepts	18%
	Prepare for future study	18%
	Complete a related project	21%

encountered it. So, in a way, the code/chip people are writing is always garbage code/chip, there used to be a time when I spend weeks tinkering on the current of an amplifier that is a painful time when I just cannot achieve the performance that I hoped for. Yet this problem can totally be bypassed on the systematic level, adjusting the performance requirement of each module.

Standing on the higher level today made me see more clearly. The realization that I have today is that sometimes the problems that in front of us most stringently are magnified by a large margin simply because it is sorely needed, and they are not necessarily as hard as we thought it would be. It is typical of people to sink into such situations where they are crafting a niche module and forget the system. Focusing on a tree and forget the forest, in a way. There is also a book that telling people don't put all your attention on one thing, especially when the thing is in dire need of dealing with. This may sound like the abnormal talk from an abnormal person, yet too much worrying won't take a person to go anywhere, those who made a little progress only take the time of anxiety people and spend them on much more broad things, in a way (Yorozu *et al*., 1987).

MAKE EDUCATING GREAT AGAIN

Experiments and system level view

I believe what is also necessary for a higher educated student is the ability to do experiment and do them well. The higher education usually involves lots of sophisticated theories that is too complicated to solve manually, and the way for most people to verify their theory are experiments, and this point is usually omitted in the education of higher level. The professors are typically all about the subtle theories, though themselves have gone through tons of experiments and know clearly the mechanism underlying those tricks, their students will still be kept in the dark. Making the studying slow and ineffective.

Another important usage of the ability of experiment is shown most clearly in the processing of testing. For example, after the chip that out lab designed is taped out and sent back, it must be tested properly to figure out if the design is right and how far are we from the simulation. In this case, proper set up of the experiment is needed, and we also need to understand the imperfection of the environment so that we can tune them out. The situation that we encountered is that the test chip we designed is a high-resolution data converter, and the test bench is based on a 'dirty' power source which have lots of harmonic distortions in it, and the data extraction lane we used is also not stable. Thus, the test result is discouragingly bad. After communication without mentor professor, lots of changes are made to enhance the test bench, the results are much better. The ability of experiment in a way is the ability of debug, because in the real word there is no telling that where a thing could go wrong, in fact, everything could go wrong, especially after a design is done, after the chip has been taped out and packaged, there is no possibility of telling the wave form in a suspiciously behaving node. Thus, it takes a lot of consideration in the process of designing (Jie *et al*., 2009).

A good designer knows the processes of testing; thus, they will make proper design, adding proper test points in their design, thus their testing and debug is much faster and more precise than the common design. The situation that I encountered is that the chip we designed took nearly as long as the time we did the design itself. Whereas another design, done in the same time by another teacher, taped out in the same batch as ours, is tested well, and because the teacher has lots of experience, he had added many knobs and test points in the chip. His test is fast, and the result can be tuned from the outside. Thus the ability of experimenting or, put it another way, the ability of debug is imperial not only because it will help in the process of designing but also such ability will save a student so much time to do other things. The time wasted by out time of testing and debug is used for another teacher to tape-out another chip. So, as an educator, it is important to emphasize and nurture the ability of their students of experiment.

To make the picture more complete, a successful high-level education is systematic. It took me a long time to realize that the masters and doctors who achieve some brilliant results doesn't because of one or two mysterious tricks, a properly done project is systematic the understanding of system level makes it possible to design on a higher level. Also, the well-known achievements do not come from hard-headed trying but the understanding on the system level. Take the design process of a chip as an example, a proper design never originates from the cadence software's simulator, but from the result of MATLAB, this is to provide the proof of the system. Yet the hardship for most students is that we students are typically lazy or incapable of building sophisticated models in the MATLAB, this result in a not optimistic or sometimes simply bad design. Thus, I think it can also be listed in the

education reform that the setup of mathematical modeling and verification. The trial-and-error way of design is indeed a way of design, and many students indeed use such design method “Somehow it works and god knows why”, in the integrated circuit design, we call such people” spice monkeys” because the simulator we used is called spice for short. The understanding of a system will make the design much faster and save lots of time. A deep understanding of the MATLAB software is also a great help because it is essentially a mathematical tool. There is time when I spend weeks solving a modeling problem and not finding anything, at the end, I realize the problem originates from the MATLAB software doesn’t support a variable-mode transmission matrix. Some proper understanding of the data structure of the Simulink model would help to avoid such non-necessary waste of time. The masters in one domain is because they are systematic. Without the mathematical support of the scheme, it would be hard for the processing of debug as the designer doesn’t know how the part he/she is adjusting is affecting the system.

Iteration and prototype

Another phenomenon that I observed is that the key of an effective way of doing project is fast iteration. The project or research we are doing sometimes can be such a large system that we can be literally be lost in them, not knowing what part we are dealing with. Sometimes we don’t even know why we start to do such a module from the beginning. This is because we kept our focus on the module for too long a time. For most cases, having a system that functions is much important that having an impressively performing module. The most effective and valuable step in the project is when we put together the stuff we have done and produced a prototype. The feeling of achievement and the verification of the plan is so stimulating and the process after the prototype can be simply viewed as some major or minor debug, which, as stated before, is inescapable.

Also, during the process of creating a prototype, there are also the chances to formalize the process of designing. The formalization can be helpful for the industry people to recognize therefore evaluate the project performance, thus they can give timely feedback to the student to hasten the process of iteration. Yet the formalize process is not without cost. This process can be very confusing for the students. Sometimes the students won’t be able to understand the reason why such a form is needed therefore they will ignore it or they will assume such a job is already done by someone else, which will be troublesome in the later phase of the project. Also, the formalization a design process won’t necessarily lead to an optimal design, its purpose is for the fast shipping of the prototype, after all.

Being fair and equal

The feeling of being left behind is especially toxic for any student during the process of education, it will make them lose their drive of going forward. There is a long time when I was nearly depressed, because I thought that the module that I was doing is such a trivial one that the system will be fine even without it. And there is also the time when almost everyone in the lab knows or is working on the digital processing of the signal, everyone is writing on the code whereas I was working of the circuit, transistor after transistor. The feeling of being left behind is very depressing. Yet such situation can be alleviated by proper explaining of the relationship between analog and digital modules. Made me realized that doing analog chip may as well be a worthy thing to do. Thus, this is the point I want to make: it would be great for the educator to take a while explaining and equalizing everyone’s work.

One dilemma of high-level education is that the result can be hard to evaluate. Indeed, because the content is already so advanced that even the student does not do much work, sometimes they just did some package grabbing, they can produce a nice and sophisticated result. Another common state of mind is to regard their allocated work as ‘dirty job’. Such state of mind is as good as a motivated-killer.

EDUCATION REFORM AND INNOVATION

The massive breakout of the COVID-19 virus forces most of the colleges and universities all around the world to a halt, however, in this period, schools are beginning to innovate about the way of education and begin to try out many new forms of teaching and testing. The online teaching and online meeting, even the graduation dissertation is done in the form of online meeting.

The Web-based Collaborative Teaching Model

As stated in (Jie *et al*., 2008), there are innovations about the online course long before the breakout of the virus. The Web-based Collaborative Teaching Model also known as Web-based Collaborative Learning Model (WBCL). WBCL is the process of utilizing the computer network and multimedia technology to let different learners to interact and cooperate on the same learning content to make the students have a deeper understanding and better command of the courses. It intends to build a collaborative learning environment based on the computer network to make teachers and students, students and students to conduct collaborative learning based on discussion, cooperation and communication.

Such method is, as stated, far from rare in many universities, for example, there are MIT open course ware, there also are Berkeley broadcast, and the purpose of such platforms is for the students, even for those people who had graduated for a long time to access the precious and frontier knowledge in the class. These platforms upload the videotaped class ranging from all the domains that is reached in the university. This way has another advantage: it presents all the essence knowledge from a much wider domain to students whose background are vastly different,

making it much easier for student to discover their 'destiny profession'. Such platforms originate to convenient the students who for some reason cannot make it to the classroom themselves. Nowadays they have evolved with time, into the combination of video course resource as well as forums of the related domains.

Practice shows that Web-based Collaborative Teaching Model has obvious advantages, which can make up the problems of the credit system and the construction of the new campus. This model helps in cultivating students' abilities of analyzing and solving problems and fostering the team spirit needed by the information technology workers.

Reforming Score Evaluation Mechanisms, Inspiring the Initiative of Students Studying

As stated in (Jie *et al*., 2008), to allow students to have the passion to participate in the study of object-oriented programming. We reformed the traditional teaching grade assessment mechanism. The student's grade of the paper exam is only 50%, other 50% grade is practice grade. Our college have robot laboratory, laboratory members need strong practical ability, majority of the members are selected from the students who had taken part in project training at one time or another in this course. A lot of excellent students become member of ACM contest group successfully. Students who are outstanding in curriculum projects have more opportunities to participate in institute research projects echelon. These incentives have greatly mobilized the initiative of students.

An also interesting point mentioned in (Luo and Li, 2008), is the reform of the evaluation method. As we all know, the evaluation is probably the most valued part in the education from the standing point of the students. To ensure the quality of teaching and promoting education reform, examination is essential, but the original written examination is difficult to adapt to the current computer basic teaching, because it is not a full and true test to measure students' learning results, so the reform of computer teaching examination means is very important. They have taken measures that changing students' grade at the end of term from a simple written examination results into integration of written and practical examinations, and overall grade is integration of usual performance and grade of the end. This can avoid that student study by rote to pursuer high marks blindly and can raise the level of student capacity of the computer. To improve the comprehensive ability of students, there is a recommendation that a comprehensive course design should be set at the end of each course, so that students' independent innovation capability can be greatly enhanced at the same time they may have a strong sense of achievement, which is a promotion for their further study of computer knowledge

Establishment of High-quality Teaching Force

Just as (Luo and Li, 2008) mentioned, computer knowledge updates and technology develop rapidly. To ensure that students have the computer ability to adapt to social and personal needs, computer basis teaching must rely to high-quality teaching force. This includes both hardware and software. On the hand of hardware, universities should try to configure the computer learning environment adapted to the current development to meet the needs of students' and teachers' practice. On the other hand of software, universities should set up teachers' team with strong professional knowledge and high-level application skills. Especially, construction of teachers' ranks is the key of computer basis curriculum development and reform. For teachers to truly adapt to the requirements of teaching basic courses, the level of teaching staff must be raised. Overall, the requirement of teachers is that they should have master's degree or higher and assistants should not have less than undergraduate education. The training of teachers should also be paid attention to and the on-the-job teachers' study of computer professional knowledge and application skills should be strengthened. Only do a good job of teaching force building, can we be the better to carry out university computer basis education to adapt to the new situation.

Active learning needs active teaching

Another great experiment conducted in MIT is to activate the classroom. They use stand-up recitations in groups of two at the blackboard to promote universal involvement. Looking around the room allows Hall to quickly gauge progress and intervene when needed. Showing compelling data to students on the benefits of active learning helps foster their willingness to try it. There are videos showing the mentioned methods of teaching. I believe it is a very enlightening experiment, showing that to activate students' interest, they need to be surrounded in an engaging environment.

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