FROM TEACHING TO MAKING LEARN

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Abstract *— Looking back to a long experience in teaching science and technologies, this paper presents a root cause analysis of what actually causes so many pupils and students fail. In fact the research goes for finding the constraint in the "teaching system". Starting from these constraints, injections allow for constructing a new paradigm. The current "teaching system" is changed into a future "learning system". This triggers fundamental changes in the world of students and teachers, and changes a whole school's organization. The last part of the paper identifies the obstacles that could prevent the change from happening.*

Index Terms — constraint, project-school, built environment, constructivist, interdisciplinary, cross-circular

INRODUCTION

"The changing nature of the skills and levels of qualification required by the economy put great pressure on schools" [1]. What will definitely be needed are adaptable workforces with schools providing the foundation for adapting skills in order to give a correct answer to the economy but also in order to sustain the graduates' employability. Schools will cast the quality of work forces in the whole spectrum of competences and skills' levels. Work-force quality directly impacts on economic growth. Labor-force is related to schooling but not necessarily devoted to the resources allocated by a country to schooling [2]. If Europe would like to achieve the goal of the Lisbon strategy, it should not forget that one determinant factor to improve the Union's competitiveness and social cohesion is education.

But before we dream of this school we should ask some fundamental questions. Why do so many countries have so much trouble and so little satisfaction with their almost different education systems? Why do we have strong attempts, experiments and efforts for reforms? While education is certainly also dependant from the large variety of cultures there must be somewhere a common problem. Whatever domain (science, language, technology), whatever country, whatever educational level (primary, secondary and even higher), whatever actors (pupils, students, parents, teachers, politics) all complain about ineffectiveness of educational systems. Much is focusing children and teachers, little only focus on process. Quality management however taught us that when products or generally spoken the process' output are out of quality, it makes no sense to focus on products but one must address the process. We will see that the process in itself is fundamentally concerned but that process not only means methodology but also correctly rethinking the resources' assignment. Reforms however despite their large number are not really fundamental paradigm shifts. This might stem from the fact that innovativeness is rather scarce. This is part of the responsibility of the teachers, which still see their main responsibility in a system driven by summative assessment. But bigger obstacles to innovativeness come from the political side. The period of achieving lasting results is feared to be longer than political mandates. Unfortunately the focus is not the fast results that innovation could bring in the eyes of pupils and students.

The question we would like to answer in the present paper is whether a teaching paradigm change as described could improve the education's system outcome by increasing the success rate without reducing the graduates' quality.

In a first paragraph we will give an overview of the trends for changing the education's system. Without being exhaustive we would like to underline the main streams that took place in the last years.

The second paragraph is focused on the root cause identification. In fact there is so much finger pointing when discussions around education systems rise. We will use the thinking process [3] as methodology to find the problem. Any organization that starts major changes without identifying the root cause highly risks to run into bankruptcy [4]. If a school reform fails, the consequence is impacting directly on young peoples' capability to build their professional life and career. The third paragraph elaborates the direction of a solution based upon the root cause(s). We give than a lookout to what the new future could become. The fourth paragraph gives a list of obstacles to expect for implementing the new model. The hardest part will be to convince teachers. The last paragraph concludes and gives some perspectives to continue fine tuning the model.

CURRENT TRENDS AND STUDIES

The European Commission and OECD run a large number of interesting studies concerning the 21rst century education system. In [1], the European Commission reports on results of a public consultation. The agenda focuses on skills that must be transmitted in the new century's schools. Future graduates must integrate lifelong learning, be compliant to the economy. The education process must guarantee equity and inclusion, foster citizenship and

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integrate improving teachers' quality. The self-learning process and the learning-to-learn are major means continuously underlined in the report. It also emphasizes on cross-curriculum topics and on formative assessment. Finland and Sweden are cited as examples for namely competences-curriculum reform. The goal of equity education can only be achieved if fall-behind drivers could be eliminated. Reference [12] concludes "that it is possible to improve student performance, even when students are from weaker academic levels, and who have languished in the educational system for years". The report however gives no answer to this important objective. The fact that this topic is broadly discussed shows the inefficacy of today's models that still mainly base upon classroom teaching. The report says that ' it remains to be explored how the personalization agenda can avoid systematic inequality'.

In [2] and [18], the economic influence of education systems is underlined. Relationships between quantity and quality of schooling are discussed. Focus is again on the importance of self-learning processes in [7]. According to [5], [14], learning outcomes should become the guide to future education strategies whilst it always has to be paid particular attention to where it is brought in use. An interesting comparison between traditional (behaviorist and cognitive) approaches and active learning (constructivist) are given with the conclusion that the active learning paradigm stresses for new criteria for learning outcomes. It refers in this context to a current paradigm description being fundamentally that of agricultural and industrial environment at the end of the 19th century following the 3 unities of classical theatre: time (class hour), place (classroom) and action (teacher in front of the classroom). The model that will be presented here is abandoning these unities. Learning outcomes drive away from the dominance of what schools and teachers provide. The teachers' role turns toward facilitation. Again the model we present is fully compliant to this view, and gives the mean to implementing it.

In [17], particular attention is put on the need of supporting the self-regulated-personalized-learning with adapted ICT tools. It is question of iClass pedagogical model that promotes pure individual learning as by our model. It is however not clearly stated whether or not front teaching still required. In [16], we can find an interesting view on personal learning. The notion of learning episode, which is found back as well in our model, is a well-defined period of time (we will speak about a mean time to accomplish) that is held together by similarity in intent, activity or place of thoughts and actions that occur during it *and that is not interrupted* by other activities; it has a definite beginning and ending time. In the same way that we consider the learning program as a project, [16] considers the learning project (similar notion) as a series of clearly related episodes (we call it pedagogic objectives (IPO)).

The importance of self-efficacy exploitation that helps healing fear, helplessness and fostering the feeling of controlling, optimism and motivation, and the fact that fast results are obtained creating the "I can do" effect [19] are highlighted. The model described is very close to the one we propose.

The 2008 conference on 'Promoting Innovation and Creativity: Schools response to the challenges of future societies' underlines the importance for introducing innovation and creativity in programs. It is however hard to imagine how this could become possible if we continue remaining in an every-lasting education paradigm. The paradigm itself is to change first. Lack of evidence for all is shown in [6] where the whole weight concentrates on establishing a curriculum for the 21st century but nothing is said about changing the paradigm itself.

Finally [15] is an extensive study on how to improve the teaching profession. It agrees upon the fact that a school must become a learning organization. It emphasizes a lot of leaving behind classic classroom teaching but continues sticking to the role of the teacher as a team coach rather than an individual coach. Our critic to this is mainly that we can't eliminate synchronism that is a major obstacle to performing education systems.

There is a large consensus on the importance of learning learn. Few are said of how to making it happen. There is no breakthrough change that could really mean paradigm shift.

IDENTIFYING THE PROBLEM

Unfortunately a lot of changes and reforms are thought, planned and triggered without making participate all actors. In education mainly teachers and sometimes politics are at the initiatives. Main customers are missing, namely pupils, students, parents and employers. Self-focusing is the outcome and self-focusing prevents from thinking out of the box. In our study we encompassed all actors by asking them what prevents the today's school and education system from achieving its goal. This is understood as collecting undesirable effects (UDE) The first problem we encountered was that actors don't agree on a uniquely verbalized goal and most of them have been unable at all to define the goal. A clearly expressed goal however is a prerequisite for using the methodology of the thinking process.

Defining The Goal

The root cause analysis is based upon cause-to-effect relationship built from a list of undesirable effects, preconditions, facts and intermediate effects. Undesirable effects however can't be expressed as long as the goal is not clearly verbalized. Teachers tend to set the education's goal to maximize the absorption of knowledge by their students. Does it mean that students must have a deep understanding of a specific domain? Is it at all possible to know everything from everything taught? Could it be to have important notions of a maximum of stuff? These questions helped us teachers rethinking the goal. Is knowledge still focused in the *new* notion of competences? What could be the students'

goal? Getting graduated with a minimum of effort? Becoming a genius? Parents would rather like their children becoming highly skilled people with high career potential. They certainly would like as well this process going on with little of their own involvement. Politics would see their contribution hammered in a success story. Finally employers would like to have effective specialized, experimented and open-minded labor-forces. There is much diversity in defining the goal. Moreover the goal once agreed upon must be simply measurable. The process of defining a goal is hard work for the entire non-profit oriented world. It is possible however to give a generic definition of the goal for any type of organization as in [9].

It could be easier to start thinking about the goal of a private school that moreover has the problem of winning students, parents and employers for creating its brand. This is a necessary condition to be able to sustain. Why should the goal of a public school be different? In order to achieve this, the school must firstly become a highly trustful institution. How to define trust? In his book [10], Covey introduces the 4 cores of credibility upon which trust is built, and which are integrity, intent, capabilities and records, which very often is neglected. It is straightforward to pretend to capabilities. What are claimed capabilities worth without results?

The results produced by a school must be measurable through their impact onto the socio-economic environment. In [2] we saw the correlation between schooling, labor-force quality, and the growth of nations. The Lisbon strategy can't achieve its 2010 objective is because a lot of European countries don't have enough labor-force to drive the competitiveness process. The socio-economic impact therefore depends on the number of high-skilled transferable young graduates and postgraduates. We therefore could the goal of the education as '*to maximize the number of graduates today as well as in the future'* while guaranteeing their quality through integrity and intent parameters that schools must develop as necessary conditionsas well minimizing operating expenses. It is worth to mention that quality is not correlated to the money spent for exploiting schools[2]. We easily agree that the goal is very ambitious but is perceived as rather ambiguous in the eyes of teachers. Is quantity at the expense of quality? Definitely not as long as the schools disserve the society's trust. Let's therefore briefly go back to the credibility cores. Integrating the 4 cores of credibility impose hefty necessary conditions to the education's system.

In the context of schools, *integrity* can be understood as the congruity in values beliefs and behaviours; *intent* means the fundamental motive of the school's agenda acting in others' best interest; *capabilities* are the ability to produce and accomplish talents, attitudes, skills knowledge and style, to show the *results,* and the ability to maintain a process of continuous improvement. All this, at the end becomes the responsibility of the school's management and teachers, not through claiming but through convincing the environement, inclusively the politics..

The current reality and the goal

The current reality models cause-to-effect starting from undesirable effects (UDE triggered by the question 'what prevents us today from achieving the goal'.

- Teachers are not always able to accomplish programs in the available time
- The level of knowledge of entering students not always corresponds to what teachers expect
- Students are not interested in many courses
- Teachers need a lot of time to level students
- Classes are too large for individual coaching students
- Teachers have no time for teamwork
- Students feel that they lack of practice during tests
- Students hardly see links between the different courses
- Students don't agree upon the importance of homework
- Parents have no time to coach children at home
- Parents have not the skills to help their children
- Students feel that most lessons are too theoretical
- Students lack of time to absorb the stuff during lessons
- Students can't go back to issues they are lost in lessons
- The number of different topics and courses is too large
- Schedules are not always accurate.
- Teachers feel pressure from parents and politics
- Teachers feel forced to lower quality of courses
- Teachers feel unpowered to improve results
- The school managers have not the liberty of choice when recruiting teachers
- Schools cannot choose the students they would prefer
- Not all teachers are truly committed to the goal
- Teachers are frustrate by the ongoing reforms

The tree containing 94 UDE, effects, preconditions can be provided to readers on request. The advantage of the tree is a consistent reduction of items to focus to and it underlines *the constraint* of the system, in our case definitely the *lack of time*. It clearly shows that stakeholders live in conflicts struggling for compromising rather than adressing and stop it. But is it lacking of time or wasting this time.?

In secondary school there about 30 lessons a week and 10 more hours home. The question is not how to increase the available time but how to better use or to exploit it, which means maximizing the outcome with respect to the constraint. The tree allows for identifying a lot of time wasting sources lasting from inability to active learning through social inequity, multitasking and forced synchronism.

THE SOLUTION

Changing a paradigm means elaborating a complete set of new rules and processes. The direction of solution is

evident. The focus must change to the student. We all claim that it him student but what is reality?

The new paradigm could be based upon some very simple rules and changes. Following *injections* could help healing the system.

- Each student is a particular project
- Project tasks are exclusively executed by the students
- A task outcome is the achievement of one IPO
- IPO are designed for achieving in a mean limited time
- Students work at their own speed and are coached
- Resources are distributed according the students' needs
- Students exclusively work at school from 8 to 18
- Teachers are available during at school from 8 to 18
- Each IPO be accomplished prior to go to the next one
- IPO are tested individually
- IPO and related theory are exposed in a short DVD spot
- IPO are accompanied with learning material
- Classrooms become open-space offices for students
- Classes and lessons no longer exist

In other words the learning process is fostered, allowing students to go at their own speed with a high degree of control. The mean time is derived from the task time lognormal distribution, as 50% chance to accomplish a task. This means that the new paradigm accepts that some students finish earlier, others later. In order to avoid the student syndrome and the Parkinson law [11], time pressure exists. On the other hand students know that they might in some cases need more time. The time control is performed by a buffer management system. Each student is assigned project buffer aggregating task contingencies at the end of the project. The project and task managers (TM), former teachers, have two new roles: coaching students, watching the buffer penetration, consumption and consumption rate, thus watching the students' advancement, according to the critical chain project management [11].

In the same way we built a current reality tree from UDE, we build a future reality tree from the injections. We give the results as a list of *desirable effects* (DE) that are generated.

- There is no more time wasting driver effect.
- Some students will get their grade much earlier
- Students that have more difficulties are more supported
- Exclusively learning processes are fostered
- Students remain stuck to the current IPO because they cannot go further before achieving
- Students improve their process of better learning learn
- Students are not dependant on help from their parents
- TM work by exceptions and focus on students in need
- TM have much more time to develop and improve IPO material, foster cross-circular topics and to eventually start teamwork with their colleagues
- TM analyze the reasons for buffer consumption and exploit it for continuously improving the system

All TM mainly work by exception. Despite a certain run-in time, the system will rapidly converge to an almost interesting equilibrium. According to the task time distribution, 50% of the students will finish on time with very low help from TM. 30% will finish in a about half the time without any help. 20 to 30% will be slightly over time but still largely in the buffer time. The lasting 20% will be those students that today have no chance to become graduated, those as well of whom nobody cares today. They will require a lot of attention. This is good news as coaches only concentrate on 20% of all students and free up capacity for improvement projects. While this represents a huge paradigm change, we don't change a lot of elements. Neither students nor content, nor teachers are changed, but the way resources are used and assigned to the students. This is the main lesson learnt in [3], [11] and [12]. One major change is that we switch the system focus from teaching (the teacher) to learning (the student). What are the results?

- The leveling process has become part of the new model. Students incorporate themselves the process asthey are given the time they need to ultimately achieve IPO
- Social inequity is eliminated. No homework anymore.
- Social life in school is fostered with the increasing presence of everybody in the school.
- Students' motivation is increased. The way IPO are designed foster quick wins and fast results. They feel supported by their task managers rather than abandoned and punished. They will work harder and harder improving themselves during the grading process and regain buffer needed in the beginning.
- Multitasking is not possible
- Students only have to be synchronous to their own project while feeling a necessary but wealthy pressure.

Suddenly UDE are changed to DE. There are moreover interesting side effects. Students can't give up. They have to go on by themselves or with the help of TM. They endorse high responsibility but at the same time they are given empowerment. The continuous learning process makes them better prepared for higher education and for the professional challenges [1]. The change will have a great impact on the construction program of new school buildings. The process will become an important input to a new research domain in the construction world, the 'built environment' [13], [8].

Moreover better results and less expense help improving the education system's perception in the eyes of the whole society. Finally the model eliminates the social inequity as schools become more democratic.

Finally it is worth mentioning that former teachers become more exchangeable. The available coaching capacity goes increasing with the better exploitation of their large polyvalence.

THE OBSTACLES TO MAKING IT HAPPEN

No change without resistance and obstacles. Obstacles can be overcome. A logic sequence of all obstacles gives a good

idea about the implementation project, the required resources and the lead-time.

- O: buildings are not adapted to the model
- O: IT infrastructure is insufficient to provide an adequate working place to ach student
  O: Follow up and time control of all students require a critical chain and buffer management compliant tool.
  IO: Tools exist. The implementation in this particular environment is straightforward. (Single template)
- O: Students are not used to and rather afraid of he new model
- O: Teachers resist to spend whole days in the school
- O: Parents are afraid of children responsibility
- O: the breakdown into IPO does not exist
- O: Pedagogic material for self-learning does not exist.
- O: We lack of early adopters to run the model.
- O: Peripheral school activities loose their today's slots

CONCLUSION AND PERSPECTIVES

Conclusions And Perspectives

We have presented a new model for the education system, which is a hefty paradigm shift. It fosters the self-learning process by episodes at the expense of classroom teaching. It is a mixture of a of few directive instruction and a large part of guided discovery. In terms of Baumgartner's typology it comes out as tutoring and coaching thus complying with constructivist learning. It integrates the self-efficacy exploitation that heals negative symptoms of students like fear, helplessness and fosters a feeling of self-control, optimism and motivation. Fast results are obtained creating the "I can do" effect [19]. The model construction is the result of three major drivers.

First, the EC reports and OECD studies underline the changes and results that new models should induce. Those are competences for all, lifelong learning, economic growth, equity, inclusion, citizenship, cross-curriculum topics, formative assessment. *Second*, an experimentation of the model in the frame of making learn digital signal processing run by the main author produced amazing and encouraging results. *Third*, an important step is the confirmation of the model through the thinking process. Starting from undesirable effects, pure logic builds the model. Let's underline that more than 90% of all thinking processes run by the authors led to utmost successful results.

The model changes relationships between students and former teachers. The teacher has been the knowledge creator, strongly related to very specific topics, and becomes various roles: tutor, project manager, coach task manager keeping track for the different tasks. The model however has to be experienced. Therefore, the obstacles must be overcome. The change must be correctly managed. The best way would be to start with a group of early adopters.

The model mostly concentrates on the learning process. It does not give so far any idea how to foster social life in school through events and actions. It only provides about 2 hours a day slot to be used for lunch and social activities.

The model does not explicitly encompass the integration of school and economy. One must think to provide IPO consisting in living a certain time in companies and defining a process of improving IPO in general.In order to evaluate the model, measurements have to be engineered.

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