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POL regarded as a competitive advantage and as a mean to maintain programmes updated

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INTRODUCTION

The title of this article indicate that Project Oriented and Problem Based Learning – POPBL - can be regarded as a competitive advantage for an institution, and be a way of keeping programmes updated with respect to the demands from a modern and fast developing society and demands from students as well. And indeed this is a possibility, but it is not a natural consequence of a change into a POPBL teaching and learning environment. In order to have these advantages developed, the education needs to have built in mechanisms that actually let the desired objectives the possibility to develop.

The organisational setup must find ways for a structure where the essential changes can take place in order to harvest the fully benefits from an educational system that depend on cooperation with Industry or Society and which depend on the latest developments in science and research.

Many Institutions have changed their way of teaching and made modifications to their educational programmes and curricula, but not all have managed to utilize the fully potential of an educational philosophy like the one Project Oriented and Problem Based Learning – POPBL – can offer.

The reason for this - in the author's experience – is that institutions have not been able to overcome internal barriers and thus not been able to fully support the entirely expansion of the POPBL technique, and thus not being able to harvest the benefits, of which such programme is potential. The process for implementation of POPBL in institutions is further described in [1] and to which level it can be managed relative to the possible changes in the organization is described in [2], and therefore not focused further in this article.

The acronym POPBL refer to Project Oriented and Problem Based-Learning carried out in teams. POPBL is sometimes referred to as POL, which is an acronym for Project Organized Learning, which however widely covers the same content as the POPBL in this article.

WHY MAKE A CHANGE?

We have to face the fact that traditional methods are no longer always adequate. The answers are no longer to be found within the profession itself. [3]

When an institution decides to make a change, it needs to be able to give an answer to the question “Why are we making a change?” as this most likely will be the first question anyone would ask. So indeed, why make a change?

The first paragraph gives an interesting and vital answer, indicating that today's world is very complex and we need to look at it as a complex interacting one where problems that graduated students must solve are equally complex and interactive.

There can be many reasons to support the wish of making a change. Some characteristic reasons are listed here:

- a. To attract better and - if preferred - more students.
- b. To improve the learning outcome of students.
- c. To improve the conditions for the staff.
- d. To establish an interdisciplinary learning environment.
- e. To sustain integration of research in the education.
- f. To present a teaching and learning institution that matches the demands of modern society.
- g. To sustain a learning setting where solutions are correlated with the context of which it will serve.
- h. To create a setting where changes in demands from industry and society can be integrated in the curriculum when the demands appear.
- i. Increase the cooperation with industries and society.
- j. International competition.
- k. Economical motives.
- l. Demands from staff.

Table 1: Listing of possible incentives for considering a change in an educational setup.

There may be several more reasons and they may not be limited to just one of the above-mentioned topics, and most likely, the reasons will be a combination of more than one of those topics.

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Later in this article, some of the topics will be evaluated through a possible POPBL programme model.

THE SETTING FOR A LEARNING ENVIRONMENT

Today most teaching institutions are not just institutions transmitting knowledge by professors. They have created various settings for their curriculum in which knowledge acquisition is by students and in which interaction with practice is possible. This could be practical problem solving activities based on ideal problems developed by teachers or academic directors. It could also be based on real problem or clusters of problems formulated as a case for students to work and try to solve. However, institutions are moving towards more complex teaching models, which facilitate the best possible learning for students and which conveys students to serve as professionals and competent resource persons for society and industry in the future.

Depending on the objectives and aims, different models can be utilized to facilitate the students' learning.

	Knowledge	Reasoning skills	Self-directed learning skills	Motivation for learning
Lecture-based cases	1	1	0	1
Case-based lectures	2	2	0	2
Case studies	3	3	3	4
Problem based	4	4	4	5
Authentic problem-based (POL)	5	5	5	5

Figure 1: Five types of teaching and the learning outcome for four competences. Scale: 1 is the lowest value, 5 is the highest value [4].

In Figure 1 different teaching methods are listed and the learning outcome is compared for four competences. The figure illustrates how the different methods are rated where 1 is the lowest rating and 5 is the highest rating for developing the competences chosen. The phrase "Authentic" is used to emphasize working with real problems, which can be characterized as POL. The "(POL)" parenthesis in the figure is this article's author adding.

In this illustration, it is clear, that the more students are involved and actively working by own learning, the higher the outcome of the competences.

In spite of not being complete as it lacks many of the characteristics used in the different models, it gives a good idea of the learning possibilities for students from the chosen competences. However, by adding additional dimensions to the POPBL technique, students' learning outcome can be increased further.

A DIFFERENT APPROACH MODEL

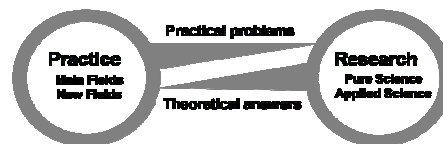


Figure 2: Practice and Research interrelations [Based on 3]

Figure 2 illustrates how industries and society (practice) are interacting with research institutions. Research institutions are giving theoretical answers to practical problems in industry or in society. Research institutions can give theoretical answers to practical problems for industry and thus supporting the further developments of the industries. This situation is well known and a well-established situation beneficial to both parties.

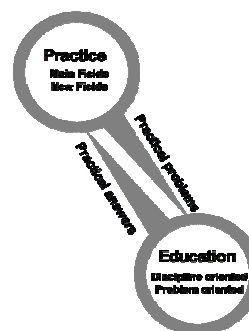


Figure 3: Education and practice interrelations [Based on 3]

In Figure 3 the interaction between education, industry and society is illustrated. Here the interrelations are focused on the practical issues, where industry or society can generate practical problems for students to be able to work and to find practical solutions. This situation can generate very fine projects, but it is lacking the correlation with research to make it an up-front situation.

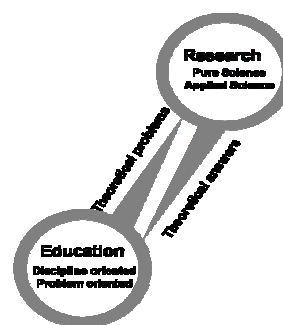


Figure 4: Education and Research interrelations [Based on 32]

Figure 4 illustrates the relation between education and research. Institutions with research departments are able to conduct research based learning and the interaction between research and education is an essential issue to be able to offer students the most excellent and up-front education. Education can deal with theoretical problems and research can deal with theoretical answers to theoretical problems.

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A POSSIBLE BENEFICIAL MODEL

A successful educational system depends on a comprehensive interplay between profession, research and education. The problems, which are to be found in professional practice and research, are the best guides for the learning process. They are the adhesives which bind practice, research and education together, and which make the result stronger than the single components [3].

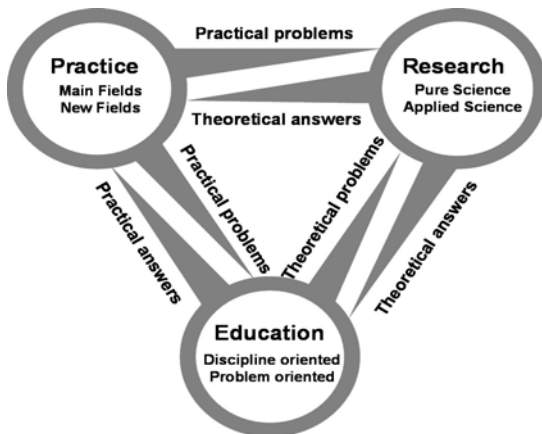


Figure 5: A dynamic educational model illustrating the philosophy of POPBL [3]

After having shown three different interrelations between education, practice and research in Figures 2 to 4, Figure 5 illustrates the joining of the three areas. This illustrates very well how it can be possible to establish a teaching and learning environment that combines the three areas. This model is the basis for the philosophy of POPBL model. The benefits of this model or educational setup are many.

THE COMPETITIVE ASPECTS

By working on the principles of a model like the one in Figure 5, it is possible to create a setup in which students are having close relations with research. Not just by applying the results of the research, which would be the situation in Figure 3, but as active participants in research in the developing. They can test preliminary research results in projects or they can be the ones on which the research is tested. The first situation is a proven model, where the latter may a bit peculiar. First year students at Aalborg University are actually sometimes being exposed to new developments in evaluating educational models. The first year is in its setup foreseen to serve as an active experimental pedagogical laboratory and pedagogical training facility for teachers and supervisors. Moreover, since there are approximately 1.000 students spread over many groups each year, it is possible to make research to see the results as for comparisons can be instantly made.

By involving research in the education, institutions also have formed a basis for creating a development process where the newest research results immediately can be utilized in projects and thus very beneficial for the industry and society. This illustrates very well the benefits of having a curriculum that is able to utilize new educational requests based on the newest research results. The students' works are principally

based on the most recent knowledge. Through the students' projects, the theoretical answers to practical and theoretical problems are conveyed directly to the industry and society.

If the structure of the curriculum and structure of the education is prepared for "instantaneously" changes, much of up-front learning can be generated. The structure does not need to wait for a change in the study guide to implement new courses focusing new areas and thus replacing old obsolete ones.

In addition to the above discussions, the quality control aspect can be interwoven into the discussion. The project environment is unique to test new tendencies or trends, as students in their work will be very good evaluators of the novelties. Those changes that make sense in this full-scale test will stay in the curriculum, but if the novelties do not bring any developments or are simply not useful in the project work, they will be abandoned very fast by students. The situation is created within the environment itself, and not because of internal or external evaluators or advisors that by nature must react much more slow to changes than students and supervisors who are acting inside and directly with the topics. A futile course will just not be used, and thus a waste of resources to keep on running it.

POSSIBLE WAYS TO CONDUCT THE MODEL

Showing models is one thing, but how can it be possible since students are not "ready" to participate in research programmes because when they enter the programme they have no experience or professional knowledge?

To illustrate this dilemma an example is useful. Some of the first year teams in the mathematical area at Aalborg University are working with projects where they use wavelets to improve picture compression to be utilized in hospital environments where doctors would like to use wireless PDA's to get direct access to look at e.g. x-ray pictures while being with a patient. The problem is if the doctors could be able to see e.g. a crack in a bone structure in a quality where it can be useful in the diagnosis work without compromising on the overall quality. A quality where they still have clear pictures on areas where changes at the pixel levels are significant where other areas are alike and thus not "interesting" in a picture or data perspective. Moreover, to be able to make it so data-sparse that it actually can be used with a PDA. This is research in its making.

The example illustrates very well how students can work with up-front research topics and be able to do small bits of investigations as they go along with the project. In this case, the supervisor/facilitator is working with the problem, so the students are up-front since they are discussing the problems with the researcher directly. In addition to this, the students get a chance at this early stage to get an idea of what research is and on the methods, data handling, mathematics, etc.

Students will be able to handle more and more complex problems and to work more and more independent at the final semesters.

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The following Table shows a possible way of thinking when designing projects for different semesters.

The first semesters	Practice and research <i>related</i> projects
The middle semesters	Practice and research <i>based</i> projects
The final semesters	<i>Complete</i> practice and research projects

Table 2: Matrix showing how the projects move towards more and more complex projects.¹

In general, the students on the first semesters can work on industry-related or society-related projects. They are not at this point able to undertake major complex projects, but they can easily manage to solve parts of a complex project. The above-mentioned example illustrates this very well. They worked on a small part *related* to a complex problem.

At the middle semesters, the projects can be directly *based* on problems that are more complex. Some fifth semester students in data engineering were looking at a real problem known by truck drivers when they are manoeuvring their big trucks backwards. One single truck with a single trailer is relatively easy, but with two trailers after the truck, it begins to be hard. Moreover, what if there are three trailers on the truck? The students worked on how to make a steering which by entering an angle for the turn would control the steering of all the trailers and make corrections according to the readings from the devices on each trailer.

They made a test truck and three cars based on Lego® parts. The reading devices, steering control, etc. was programmable units made of standard components. When they finished they demonstrated how the truck managed to turn even a truck with three cars into a circular movement, which could be kept eternally. The trailers could be arranged with different angles between them in the starting position, but the reading, steering and correction devices worked perfectly, and the truck and three trailers were manoeuvred into a steady circular movement very fast.

The project uses research results from the control areas and the results can be directed as tested high technology to the industry to be developed further for commercial use. In this case they worked on developing a device solving a real problem, but it does not give solutions to how it actually can be built in. They miss to prove it in full scale and thus the project is limited in relation to a complete project and it is only using the data science, where a full-scale setup would need an inter-disciplinary approach. Still they work on a project *based* on a real problem.

By the final semester, students should be able to work with complete projects and come up with complete solutions where all aspects should be investigated and integrated.

Maybe they will not be able to complete the total project, but this is a simple time problem.

In conclusion of this section, the examples illustrates that it will be possible to find real and interesting problems for students to work by. The limitations for not doing it however are in the author's opinion to be found within the institutions. Barriers could be caused by traditional thinking, lack of cooperation with industries and institutions or limitations in the institutional structure itself.

Further, the examples illustrates that if the research or practice change the requested competences, it will be possible to make a change very fast basically by changing the courses that supports the new competences to be utilized immediately in the projects. One example of this can be the development in the CAD/CAM manufacturing. Some years ago, it was in the research area, and students worked on developing steering etc. Some years after, the development had moved further, and all the projects working with those developments were obsolete. It was no longer interesting, as it has been commercialized and thus not of interest in a research perspective at the university. It was now left to the persons manoeuvring the machinery and thus just a trivial "technique". The projects moved on further towards *systems* that are more complex and the requirements of students' competences have changed in relatively short time. The industry did not need the CAD/CAM competences in engineers anymore. The work was taken over by technicians.

The research perspective is able to push students further than just solving trivial problems as a means to learn.

SUMMARY

By evaluating the discussions in this article with the incentives for considering a change, it might be possible to get an idea on whether POPBL could be a way to sustain some of the incentives listed in Table 1. In the following text, the letter is with reference to Table 1.

a. By offering an interesting and challenging educational environment, where the student feels he/she will be able to work with things that interest him/her, it will be a very powerful advantage in comparison with traditional taught institutions. Some students will apply simply because the education is exiting and fulfilling their expectations. And students happily spread bad experiences as well as good experiences to friends and peers.

b. By using the POPBL approach and by focussing on technical competences as well as on personal skills and abilities, students will be better prepared for their future performance and match the expectations formulated by a modern communications and collaborative society.

c. POPBL can be a way to create a more interesting and inspiring environment for teachers, as they are not only teaching but as well acting as supervisors. Moreover, by working with projects, the variety of projects is very challenging for teachers as well, and they will have the possibility to be working with research topics in their teaching and supervision. Teachers used to an open teaching

¹ This table has been used in the author's workshops in Mexico, Malaysia and in Thailand. E.g. [5]

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environment like working with projects are not likely to return to traditional systems. The project environment also serves as a way to develop the teachers' qualifications, as they are pushed into new areas and to seek for new knowledge for students.

d. In traditional teaching, interdisciplinary activity is not easy to create, but the project environment actually demands cooperation between teachers from different professions as they have to develop projects and act as supervisors together. This encourages teachers to interact socially across different disciplines and professions. As stated, complex solutions to complex problems cannot longer be solved within the framework of the particular disciplines themselves.

e. By a project structure that uses practice as well as research, the research aspect comes natural into the teaching environment. Most projects may even be generated from research areas, and thus the teaching and learning becomes research based teaching and learning, and this will even have impact on the institutions rating nationally and internationally.

f. Having created an environment that through the projects "listen in" to the new demands from practice and research, the students graduating the institution match very well the contemporary demands from industry and society

g. Focusing the context in which a problem and subsequently solution will act is a natural issue in a project environment. In addition, a solution that does not match the context in which it serves, is normally a not valued solution. Any solution must meet the demands set by the surroundings. The project work is an excellent environment to support the contextual topics.

h. Working with projects that closely uses research and practice as basis, means that whenever the requirements from practice changes or new results in research are present, the project work is the environments that first realizes the changes and the students and supervisors naturally react to them. So in a way the project work can be considered as the tentacles or antennas of the institution to be updated in new demands or discoveries, and they can keep and expand a leading position in the area since they are constantly focused on the state-of-the-art developments in industry and society.

i. It is obvious that if the projects are interacting with industry, then the cooperation with industry will increase. However, this is a very valuable situation for institutions, as industries are very important partners and the ones that employ the graduated students. They prefer the most qualified persons, and by offering good projects, they are part of the development directly.

j. Institutions are rated on many things, but one of the things looked upon from the outside is how they manage to keep their educations updated. So offering up to date education will rank the institution higher nationally and internationally and open up for cooperation with peer institutions of which both parties can benefit.

k. The economical factor is sometimes used as one of the incitements for making a change, but in the author's opinion,

the money available for teaching is always spent, and this situation will most likely not change just by changing to a new teaching method. Maybe the money will be spent differently, but they will be spent anyway. Therefore, in the author's opinion, economy should not be an incentive for making a change.

l. Demands from staff are possible reasons for institutions to consider a change, but most likely, their demands are based on other incitements. To have staff members that are ready for change is a positive situation for executives, as these people are very enthusiastic resources that will support a change process and could be the ones leading the implementation.

Looking at the incitements listed in Table 1 held against the reflections above, the POPBL teaching and learning method seems to be one of the ways that could fulfil the incitements. Maybe this could be said by other methods as well, but this does not mean that the POPBL method is *not* useful. The method is a complete method that gives room for developing competences additional to the ones related to the profession itself, and if structured well, POPBL is a system that within itself is organized for change. The POPBL method is indeed a strong competitive parameter (compare with Table 2). That is, if the change is made known to those who consider matriculate at the institution.

The former Dean, Dr. Román Moreno of ITESM Campus Hermosillo, México has told this story to me during a workshop session in México City in 2002.

When we had the first project exams, the students asked if their parents could oversee the examination. They got the permission even though the Dean was a bit worried and anxious with the situation. During the students' examination, the parents were present and were very enthusiastic in what happened, and after the examination, the parents wanted to discuss the project further. They felt they had been part of the project all along discussing with their sons and daughters in the process, so they would like to be "examined" as well. [Dr. Román Romero]

A situation like this will be very valuable for any institution, as for there could not be better ambassadors for this technique.

CONCLUSIONS

Through this article, questions have been raised and some attempts to give answer to them as well. Looking back to the title of the article "*POL regarded as a competitive advantage and as a means to maintain programmes updated*" the answer to this must be a clear yes.

However, the "yes" comes with a price, and that is that institutions must make room for the developing of the technique, and make it possible in the structure of the education and curriculum to have some courses supporting the project work to be free to change whenever is needed reflecting changes in requirements from industry, society and research, without a total restructure of the guides etc.

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The formulated vision at any institution or department, pictures a situation on where the executives would like to see the institution to be within a certain period. The vision most often uses the commonly accepted skills and competences focused on students and the surroundings. However, some of the topics stated in the vision calls for changes in the structure and organization of the institution – and staff - to be fulfilled. By creating an educational and learning environment that is so open that most changes can be absorbed without making any structural changes, gives the executives improved possibilities to set up very ambitious objectives in the vision, as they know they have created a system, which will be able to fulfil the imagined picture. Moreover, the executives have an organization where changes can be made quickly in order to keep updated is an additional benefit, as the structure itself will be calling for these changes, and there is no need for internal or external developers to estimate when a change is appropriate. The POPBL environment make the test within the system, and the changes not able to survive are taken out of the setting just as fast as they entered. Thus, the POPBL in itself is a quality insurance programme on top of the other advantages.

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