Project based teaching was the answer. But what is the question?

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ABSTRACT

Project based learning (PBL) has been praised as a teaching method. Lecture based teaching has, on the other hand, been regarded as old fashioned, boring, de-motivating and a waste of time [1] . "Tell me and I will forget it, show me, and I may remember, involve me and I will understand", a proverb attributed to Aristotle (394 – 322 BC), has served as a beacon for project based learning.

This paper reflects on different teaching models, on learning motivations and on the questions that need to be asked when deciding which teaching models to use. Do we sometimes abandon good methods for the wrong reasons, or stick to methods that may not be the correct ones?

A learning model is presented and its implications for PBL and lectures are discussed.

A rudimentary example of e-learning tools sheds some light on the potential of lectures

Keywords: Project based learning, learning motivation, storytelling, best practice lecturing, e-learning.

1. INTRODUCTION

Background
This paper is based on 25 years of teaching at a 5 year continuous master programme in Industrial design at the Oslo School of Architecture and Design. PBL has, since the school was started in 1945, been the school's major teaching method. A typical master and apprentice model was first used. Over the years, what could be labelled a studio model has been developed. Masters of trades are still present and working with the students, the students encountering several kinds of expertise in their day-to-day work such as historians, anthropologists and engineers. The student/teacher ratio at our school is also very good, on average 7 students for every teacher. This rather luxurious situation is, however, about to change [2] Class sizes will increase and budgets will be cut. Lectures seem to persist as the dominant global teaching method [3] The pedagogical model has, over the years, developed into a mixed model, students today spending almost all their time in studios working on projects. Lecture courses are at a minimum, although lectures are (of course) given in the project period. Experience has shown that some of the curriculum is best covered by series of lectures. I will, in the following, try to provide reasons for the three types of teaching at the Oslo school of Architecture and Design (AHO):

1) Project based, one to one counselling/tutoring.
2) Lectures in the studio. explicit knowledge that all need to solve an assignment.
3) Lecture series that cover more overarching topics that PBL, due to its open-ended nature, cannot address.

Experience from other schools indicates that the findings are transferable, if not universal.

Adderley et al [4] definition of PBL from 1975 is used in the following:

1) It involves the solution of a problem, though not necessary set by the student himself/herself;
2) It involves initiative by the student or group of students, and necessitates a variety of educational activities;
3) It usually results in an end product (e.g., report, computer programme, a model);
4) It often goes on for a considerable period of time;
5) Teaching staffs assume advisory roles instead of authoritarian.

2. THEORETICAL FRAMEWORK

Motivation to learn
Motivation is probably the single most important factor in successful learning. There are several types of motivation. In the following, however, focus will be on the two main types of motivation. Intrinsic motivation (IM) and extrinsic motivation (EM).

IM is about inner motivation. It is fun or in other ways fulfils personal preoccupations. EM is driven by rewards and penalties. In education, this can be grades and in the context of work it can be salary. There are lengthy debates on the impact of these types of motivations. Could EM even harm IM?[5] Lemos et al [6] claim there is a strong argument for a combination of the two. It is claimed that the pedagogical strength of PBL is the intrinsic motivation involved [6].

Types of knowledge
There are many types of knowledge. To make things simpler, however, knowledge could be divided into two types. Tacit knowledge and explicit knowledge. Nightingale [7] compared tacit knowledge to physicists' "dark matter". Tacit knowledge can, however be understood as being a non-explicit competency, a skill that we practice and improve. This skill can, for example, be a physical craftsmanship or the ability to solve a type of problem, such as actively solving Sudoku problems increasing one's ability to solve them, without any new explicit knowledge being added. It is the practice itself that leads to improvement. Tsoukas [8] argued that explicit

knowledge and tacit knowledge are not opposites at each end of a continuum, but are more like two sides of the same coin.

We, to help show how motivation is linked to learning, developed the illustration presented in figure 1. All 4 types of motivation shown in the figure can be aligned with one or more teaching method.

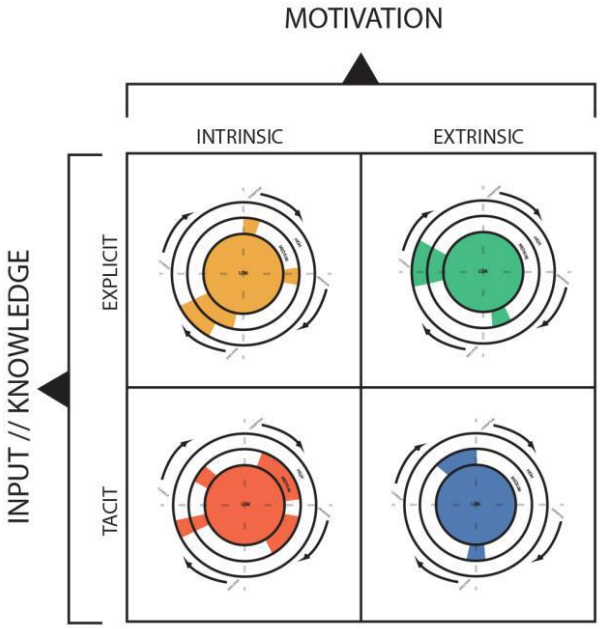

Figure 1 – Four types of motivations are derived based on the two types of motivation, intrinsic and extrinsic, and the two main types of knowledge building, explicit and tacit. (Maria Karlsen, Steinar Killi, Andrew Morrison)

1) Top left. Intrinsic-explicit. This includes general lectures, either given at the school, or viewed via the Internet or TV. Primarily inspirational input.
2) Bottom left. Intrinsic-tacit. This includes facilitating, admission to workshops, laboratories or just allocating time to projects. Space to learn is becoming an important asset [9].
3) Top right. Extrinsic-explicit. Includes lectures that answer specific questions asked. Also shorter instructional web talks that address these questions and meetings with experts in a field.
4) Bottom right. Extrinsic-tacit. This also is inspirational. However, a clear awareness of this when choosing teaching method. Lectures can be a good alternative. However, this type relates to "tacit memory" and lectures should therefore ideally use the storytelling format.

In 2015 I developed a model to foresee when the motivation to learn would peak in a project period [10]. Figure 1 depicts the four learning situations. The ability to recognise and foresee the four situations would allow us to allocate resources and teaching methods more accurately. Figure 2 shows the four types of learning in a project period. The cycle follows the four project stages defined by Archibald [11] which are conception, definition, execution and closeout. The timeline and the different opportunities provided at different points in the cycle lead to the conclusion that different teaching methods are also required at different points in the cycle. In some periods, students gather explicit knowledge by themselves. They, however, in the main part of the project period enhance their tacit skills, for example through drawing, using the computer and being in the workshop. The teachers' role is, in some periods, to be a facilitator, a role that it is argued is problematic due to misuse of pedagogical resources [12] . This paper will not, however, elaborate further on this discussion. The cycle also shows the need/opportunity to deliver explicit knowledge, which is usually best achieved using the lecture format.

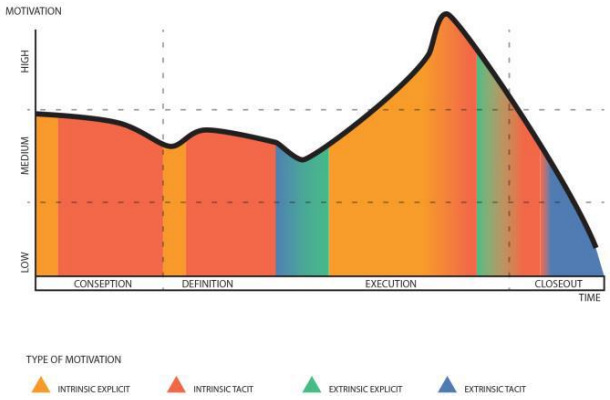

Figure 2 – The motivation cycle in a design project. The curve shows the overall learning motivation throughout the project, the colours depicting when each type of learning motivation arises. Resource use and other planning can enhance this curve. The curve is not static. It changes with influences such as type and length of project, types of students (advanced, beginners) and type of learning outcome aimed for. (Graph by Maria Karlsen, Steinar Killi and Andrew Morrison).

Figure 1 and figure 2 show that the diversity in learning motivation and motivation phases could release several teaching/learning opportunities. How a method is used is (again) as important as the method itself. A lecture could easily be turned into a discussion, interaction in this being at both the verbal and physical level.

Three types of teaching at AHO

The Oslo School of Architecture and Design (AHO) use three types of teaching.

1) Project based, one to one counselling/tutoring. Each student is treated individually, the teacher serving as a master who gives the apprentice advice and guidance. The teacher could also be an expert from another field of expertise such as engineering or anthropology, who discusses individually with the student specific challenges in the student's project.
2) Lectures in the studio. These lectures could be of an introductory nature and provide a common insight to the whole studio. The lectures could also share the explicit knowledge that all need to solve an assignment.
3) Lecture series that cover more overarching topics that PBL, due to its open-ended nature, cannot address. An example would be history. It would be difficult to teach a course that covers the whole of design history as a project. Parts of the curriculum could, however, be exemplified through short projects.

The complex and potentially contradictory outcomes of design intervention mean that designers are forced to move between iterative phases of *action* and *reflection*. This concept was introduced by Donald Schön [13]. Schön's concept has strengthened a belief in PBL as being a best practice method, not just in design schools, but also within other disciplines.

This paper set out to reflect on the different teaching methods. PBL has, however and despite this intention, so far received most attention. This is no doubt a reflection of the strength of project based learning. Could lectures, however, gain momentum from an insight into PBL, the different motivation types and the motivation cycle? [10]

Lectures, best practice and new possibilities

We can all remember some great lectures. They are probably also more significant than we realised at the time. What, however, makes a lecture great? Why do some people pay thousands of dollars to listen to, for example, an ex-president of the USA or a Nobel prize winner? There are many answers to these questions, some of which are not transferable to the school situation. For example, the fame of an ex-president or Nobel laureate is unachievable for most teachers. However, neither an ex-president nor a Nobel laureate could survive without being able to incorporate two key components into their lectures. Content and delivery. Ex-presidents, through being politicians, usually excel at delivery and Nobel laureates usually excel at content. Those who travel the world delivering their lectures for fees of thousands of dollar usually excel at both. In the student lecturing context, content that is both valid and of initial interest to the students is an absolute prerequisite. What makes a great student lecture is therefore not just content, but to a large extent how the lecture is given.

As stated by Schönwetter [14] "Effective learning is characterised by enthusiasm and expressiveness, clarity and interaction". A quick Google search provides an abundance of tips and tricks on how to achieve these. Something has, however, changed over the last 10 to 15 years. Students are today continuously bombarded with sensory stimulation in the form of, for example, social media, YouTube and games. What worked in 1999 is therefore unlikely to work in 2019. This is not necessarily due to students' shorter attention spans, but due to the sheer volume of this bombardment [15].

I, reflecting on my own lecturing practice, see three shifts. All are primarily due to technological changes. At the beginning of my lecturing career, from 1994 until around 1998, I gave long lecture series in material science, manufacturing methods and mechanics using just an overhead projector and a blackboard. The lecture series ended with a formal written exam, which was graded. This worked at the time. My enthusiasm and the relevance of the lecture content resulted in good student evaluation feedback. The first major change I experienced, the introduction of PowerPoint in 1999, resulted in a total makeover of my lectures. Lectures now included images and even videos. The content was, in general, the same. My enthusiasm was perhaps a little lower. Clarity and expressiveness was, however, better. It became clear, over the next 15 years, that some of the lectures worked well, and some did not. Another change was therefore needed. Content was still valid and important. Different approaches to its dissemination needed, however, to be designed. Two new approaches were instigated;

1) Overarching topics could still be taught using the classic lecture format. The emphasis was however now on storytelling. Examples, anecdotes, short movies and of course an enthusiastic delivery were still important lecture elements. Lecture timing should also be relevant. For example lectures should, instead of being once a week, be given every day in combination with workshops. This worked well in manufacturing technology.
2) E- learning tools, for instance interactive, multimedia tools, seem to solve one of the big challenges in teaching; understanding complex technological issues. A simple example can be given to illustrate this.

Using E-learning tools, a simple example

There are a number of interesting aspects of E-learning. One is the opportunity to learn and follow a teacher at times and at pace that is convenient to the student. The other is to develop simple interactive tasks. The following example was developed in response to the frustration experienced when trying to explain the concept of stiffness as a material dependent parameter. Stiffness and the Young's modulus mechanical property are taught in schools of mechanics using mathematical models, diagrams with curves and, if the school is well equipped, a laboratory experiment in which a sample part is torn in two whilst monitoring force and elongation. It is essential for designers and architects to understand a number of mechanical properties. Strengths and stiffness are two such properties. Initially, charts with graphs were introduced and then the students use laboratory equipment to tear a plastic sample apart to teach these two. See figure 3.

Figure 3 – Calculating Young's modulus for a 3d printed plastic sample using a stretching machine. Picture Steinar Killi.

The exam results from over a number of years however showed a steady trend. Less than 50% of students understood the material behaviour that Young's modulus describes. Most of the students mixed Young's modulus with strength and concluded that high stiffness also indicated high strength. There is a clear relationship between these properties. The exam statistics, however, show that this is misunderstood and therefore needs to be addressed. We, through talking to the students after the exam, began to understand that the technical/mathematical approach was too difficult for the students. This was further emphasised by the laboratory experiment. A very simple example was therefore designed,

recorded and distributed. We, in short, used props found in everyday life and encouraged the students to replicate the experiment. The theory and example were brought together in a video sequence that the students could replicate or just replay. The result was valid, the number of students who understood the concept and use of Young's modulus increasing from 50% to 60-70%.

We also, in the experiment, changed from using a plastic specimen that one could hardly see, to using a jelly man, a popular candy that most children and grownups have enjoyed stretching and playing with before eating it. We also changed from using a digital measuring tool to using a plastic ruler that every student has and is familiar with. The jelly man stretched so far that the stretch could easily be measured using such a simple tool. The force exerted upon the jelly man by hand was also measured using a simple hanging scale. The results used to calculate Young's modulus were therefore all measured using familiar units: millimetres and kilograms (easily transferred to Newton's). The obvious sources of errors in this experiment also got the students to reflect on these errors, and repeat the experiments, altering slightly the way they were conducted to eliminate errors. For instance, using a pre-measured scaling sheet would discard the ruler. Attaching the Jelly man to the scale without making a hole in it. Some even tried different colours (and tastes) of the jelly man to see if this would influence on the result. Figure 4 shows the simple experiment, stills from the video.

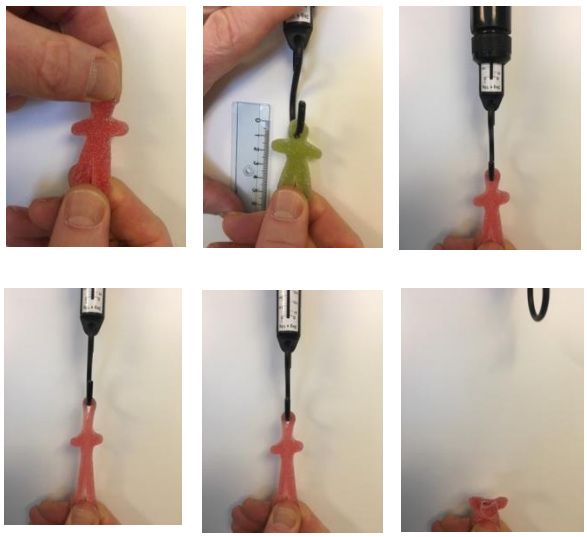

Figure 4 – Using a jelly man, a ruler and a scale to determine Young's modulus and the strength of jelly material. Picture Steinar Killi.

This experiment is, of course, neither new nor very innovative. Previous experience has, however, shown that using high tech equipment does not guarantee better explanations. What the material properties represent was furthermore, at this point in time, the only aspect of interest. The students were also encouraged to experiment with other test materials. In-depth information was, of course, included in the video. In short, using very low-tech, unprecise techniques triggered the imagination and made the learning process a bit more fun.

We introduced this method usually when we saw that lectures did not make it understandable and laboratory tests were aiming above the target, hence did not explain the knowledge better. A similar example was to explain how aluminium extrusion works, or more precise, how to make hollow aluminium profiles. In the industry, and even laboratories, heavy machinery are used and the principle of continuous cold-welding that occurs in the tool is well hidden. We solved this by using pasta instead of aluminium. Tools for extruding pasta are almost identical too aluminium. They 3d printed a pasta tool and learned about advanced extrusion techniques and material plasticity. See figure 5. This could seem like a classic PBL, but the outcome was known, it was a way exemplifying a technology. It could easily be transformed into an E-learning sequence.

Figure 5 – Pasta extrusion as a mean to understand aluminium extrusion Pictures Wilhelmine Førre, Gard Hagen and Frøya Thue.

3. DISCUSSION AND CONCLUSION

Returning to the main question of this article; if project based learning is the answer, what is the question? Project based learning has obvious benefits and has a built-in ability to adapt to both new technology and even to social trends. Working in or with projects will therefore probably increase. Most pupils and students are also familiar with PBL based learning methods. The position of lectures in the future pedagogical landscape is, however, a little harder to predict. There does appear to be quite a clear trend. The classic lecture is shifting towards storytelling. TED talks, for example and which have become so very popular, are basically lectures. The really good ones are, however, stories. Jackie Gerstein [16] has reflected on that PowerPoint lectures dull the mind but that stories can have the opposite effect. This can be seen in the brain charts of students during a week, see figure 6.

The time spent in class shows a very low brain map activity. Researchers have, however, found that listening to stories and making stories that mimic how we organize our lives [17] has the opposite effect, high brain activity. People or events are usually remembered where these are linked to a story. Marcel Proust and his "In search for a lost time" revolve around triggers that lead to us remembering forgotten memories. A smell could instantly trigger a childhood memory.

These theories about storytelling interestingly challenge Aristotle's proverb mentioned at the beginning of this paper. We do remember stories. Not, of course, all. However, those that seem to match some of our social trigger points seem to have a better chance of surviving [18].

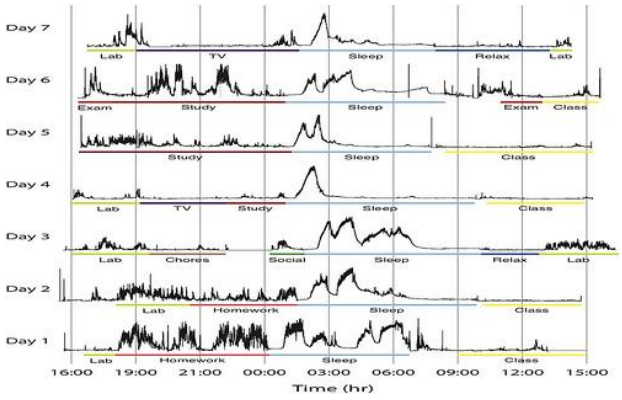

Figure 6 – Brain map of a student for a full week. The activity is at its lowest during classes. Picture courtesy: Joi Ito.com

The questions to ask when choosing teaching methods are therefore many faceted. They could tentatively be listed as follows.

1) What is the intended learning outcome? Is it to learn explicit knowledge? Or is it to understand a process and build tacit knowledge? Explicit knowledge could be addressed using lectures, but for example use story telling elements to trigger memory and interest. Process and building tacit knowledge could benefit more from PBL and targeted, short, input sessions.
2) Is a specific teaching methodology chosen because of non-pedagogical reasons, such as finances, by lack of teaching resources or students not able to meet at specific times? PBL enforced with E-learning tools could be the best way to circumvent such obstacles and achieve teaching results.
3) If the objective is to learn how to learn, then content will probably direct method. Practicing on tacit knowledge could be paired with reflections on actions, so gaining explicit knowledge on how one learns. For example, if you explain something to someone else, then you automatically start to reflect on the topic. Repeating this will generate new insight and possibly a better understanding. Whether this is tacit or explicit is almost a philosophical discussion.

Final reflections

In conclusion, this paper does not seek not to answer the initial question, but to reflect on some of the methods, models and tools used in teaching. The topic is far from fully investigated, and this paper represents more of a starting point for a discussion than a discussion in itself. This paper is also heavily influenced by the author's practice within a specific education field; design. Some of these thoughts could be of interest in other areas. However, practice and pedagogical history will probably heavily influence the methods chosen.

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