"Awareness of the importance of social interaction as part of the Bildung developmental process at Bachelor Civil Engineering program."

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Abstract

1. Introduction. In 2015 the subject "Engineering Academic Systems Thinking" was established for the bachelor programs in Norway. A need for a more solid Bildung as a base, and to be more skilled in social interaction processes is preferable.
2. Vision. Jomar Tørset has as a teacher formulated the needs to be:
"The engineers must be more adaptable in tackling unpredictable situations and also be able to do the work in different stages of a project in collaboration with people who have different background/experiences/history without compromising the demanded efficiency and innovation."
3. Theory. The students got a theoretical basis about phases in a project that can be linked to Barrows & Tamblyn "Problem Based Learning" (PBL) theory. Students have also been familiar with team dynamics by use of the SPGR instrument. SPGR is a validated tool for measuring team behavior.
4. Performance method. 23 new teams got highly relevant but different projects to solve. The performance period is 9 weeks with two SPGR measurements, in week 3 and week 6, respectively. The students had to describe where they are according these theories in week 4 and 7.
5. Results. Through such process, students acquire a common language of how to describe the situation related to project and team dynamics/processes. They are also familiar with SPGR and have the opportunity to use it in order to get a complete overview of how the cooperation interplay within teams. The students have experienced that team processes during a project do not necessarily follow a fixed pattern outlined in models like Tuckman's.

Keywords: Problem Based Learning, Academic System Thinking, Team Model, Project Performance Model, SPGR, Bildung

Type of contribution: Best practice paper.

1 Introduction and Motivation

"Education is the most powerful weapon you can possibly know if you want to change the world". Nelson Mandela, the first black president of South Africa, based his life on what he believed in. His judgements and deeds are followed by citizens, not only within his own country, but in the whole world. Our patterns of behaviour are influenced strongly by values adapted already from young age, but leading stars like Mandela may lead to change in mentality and behaviour much later in life. Your behaviour is influenced by your own values and experiences, and also by observations of what others do/have done. In addition, we shall illustrate that behaviour is also influenced by scope and context, and can be trained inside the current setting. Bildung is a German word for the combination of forming and educating human beings in a holistic perspective (Klafki, 2001) many prosperous countries, the Bildung concept has somewhat been faded as we leaned back and enjoyed our prosperity. Engineering university education has for some time focused more on the excellence and marks in the scientific topics, and less on shaping the whole person, including the broader spectrum of

perspectives, understanding the interaction and synergy of technology with human relations, society and wider social responsibility (Jon Hellenes, 1969). If covered, these perspectives have in many cases been confined to isolated university courses, and not blended into the practical teaching in the scientific university courses. However, Bildung has in some countries always been an important integrated part, also of the technological education. In many prosperous countries, including Norway, the faded Bildung concept is regaining its momentum, and the universities are redirecting towards a more holistic view of education. At the Norwegian University of Science and Technology, this has been the case for some time now, and each engineering direction has been forming their education, adding elements of Bildung into the individual scientific topics. Problem based learning (PBL) is a crucial element of this Bildung, and human relations another. The work presented in this article, displays an example of combining these; in the topic *Engineering Academic Systems Thinking* in their last year for Batchelor in Civil engineering. PBL is an excellent arena for Bildung, and we will show how the students are combining their practical problem solving work with learning on many levels and with several perspectives present in an effective and efficient training programme.

In the next sections of this Best Practice paper, we present the university course for System thinking, and the Spin model for teams and its team behaviour measurement instrument SPGR (Systematize the Person Group Relation, described in section 3). In section 4, we show some examples of how the students have worked with technology problems and Bildung in the program. Section 5 discusses our experiences with this scheme, and suggests modifications and continued efforts for educating our students in the multi-level program.

2 Description of the PBL program: Engineering Academic Systems Thinking

Society is changing. The way we do things now is probably not the same tomorrow. How should we think in order to adapt to the times to come, in parallel with learning from experience and tradition? It is more important than ever to focus on the base we act out of, and this is not just about what has traditionally been learned through education. Accordingly, we must focus on Bildung as part of the education. The importance to be more adaptable and flexible has increased. The "Norwegian Association of Higher Education" established the "Bildung Committee" in 2007. They formulated their mandate based on the headline "Bildung Committee – about Bildung Perspectives in higher educations". The result of their work was presented in June 2009 in the document "Knowledge and Bildung before a new Century" (Bildung committee, 2010).

NOKUT's vision

On this basis, the Norwegian Agency for Quality Assurance in Education (NOKUT) in 2010 established a vision for engineering studies: *As an engineer, you use both your analytical and creative skills to solve socially useful technological challenges. You must work in an innovative, structured and targeted manner. You must have excellent skills both for innovation, and for analyses, for generating solutions, for assessing, deciding, implementing and reporting, and hence you must be a good entrepreneur. Alongside Science and Technology, your linguistic skills are important, both written and orally, Norwegian as well as foreign languages. Systems that interact are an important feature of a modern society. You must be able to work independently and to work in interdisciplinary teams. As an engineer, you work with people, you are ethically responsible and environmentally conscious, and you have a major influence on society!* (Bildung committee, 2010).

This resulted in the subject course "Engineering Academic systems thinking" at NTNU, the Norwegian University of Science and Technology, based on guidelines from the Norwegian "Ministry of Education and Research" (Lovdata, 2011). For the engineering program, this course was run for engineers at the undergraduate level for the first time in 2015. The subject has 10 ETC and takes place in the 6th and final semester at the bachelor study. J. Tørset taught this subject in 2016 and 2017 at the Department of Building

and Environment, Bachelor degree, at NTNU. The expected main learning outcome is: holistic system thinking, project work and project management, quality management, methods of interaction in collaboration, and group dynamics. The main idea is that Bildung is making engineers more adaptable in tackling unpredictable situations, and also enabling them to work in different stages of a project in collaboration with people who have different backgrounds without compromising the required efficiency and innovation. They are trained to handle development projects aiming at sustainable environmental and societal solutions by e.g. carrying out life cycle analyses. In parallel, they are trained as team members, reflecting on the development process and relational aspects. Finally, they are trained in reporting the technical results.

In more detail, students are taught:
1. To solve engineering problem which is bigger and more challenging than they are used to: The students will have to do judgements and decisions based on the limited timeframe and competence they have.

2. To recognize situations. How should the students act in various scenarios? Students are given a theoretical base relative phases of a project that, in principle, can be linked to PBL (Barrows & Tamblyn, 1980). Students must each week submit an interim report with reference to the different phases of PBL.

3. To find and understand your role in a team. How to adapt their own and others' behaviour through understanding the behaviour of - and relationship to -the others in the group. SPGR is a tool that measures behaviour and the relationships between the members of a group over some time. It does not say directly what personal qualities students have, but rather how students rate their own and the others' behaviour in the group. SPGR provides a description of the perceived status quo for the team dynamics, and a language that makes it possible to understand what is happening in the group.

4. SPGR as a tool: Tools that can enable a basic understanding of relations, to plan projects according to the problem characteristics (wrt Level of Purpose, clarity, difficulty, complexity, predictability) and the nature of the participants of the group (wrt trained/untrained, competence, structured/unstructured, motivation, behaviour in the group, and group maturity).

The nine weeks of project work is for each group structured like this:

- Week 1: Collaboration agreement
- Week 2: Description of the assignment with idea and vision
- Week 3: Overview of requirements and solution elements
- Week 4: Choice of concept
- Week 5: Plan and volume descriptions
- Week 6: Interface description
- Week 7: SPGR summary
- Week 8: Technical contents, freeze report
- Week 9: Final report submission
- Evaluation by teacher

Through this process, the students learn how to communicate and to act on issues regarding the collaboration. They aquire a common language for describing relations and behaviour that makes them able to discuss and reflect. They learn the SPGR tool (ref. chapter 3), enabling a complete overview of how the cooperation of a group works. The students learn through the project experience that group dynamics processes does not necessarily follow a particular pattern, such as Tuckman's theory (Tuckman, 1965).

The civil engineering students are assembled in groups of 3-5 in the program; the group size is discussed in Section 5. They are then assigned to concrete projects, where particular cases in or around the City of

Trondheim are addressed. It is important that the cases are sufficiently challenging and interesting for the students to be motivated to use the whole spectrum of skills, knowledge and instincts to solve the tasks. The goal is that the students learn to be adaptable. Based on this experience, the students are more skilled in order to handle a less predictable world, according to NOKUT's vision formulated in previous section.

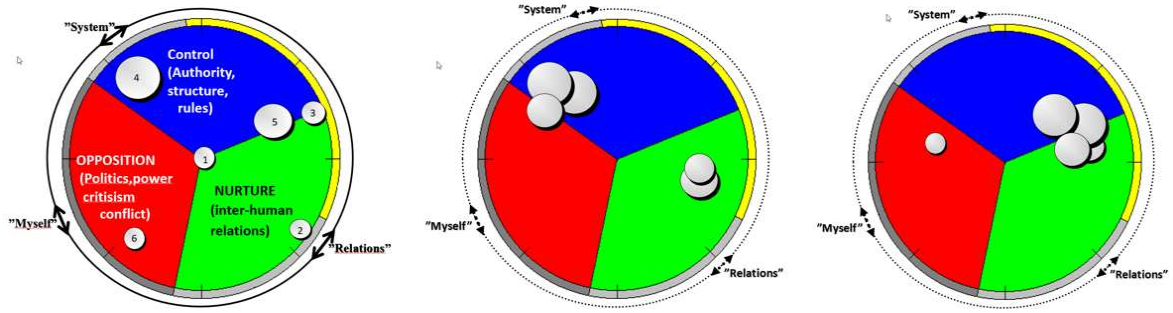
On the technological engineering level, the main purpose of the course is to perform proper research, to develop alternative solutions for the projects, to select and elaborate on the best alternative for the development of the area. The group work is performed for 9 weeks, and results in a development report for the solution strategy. The students address the group dynamics, the group processes and the individual performances in the team. The group dynamics is measured by the SPGR instrument during weeks no 3 and 7 in the work. They are given a short introduction to the team model and measurement instrument, similar to the description in Section 3. They reflect on what was going on in the group processes during the work, and on how these team characteristics influenced the work and the results. The motivation for this whole program is then to learn on a multi-level PBL training arena: the interplay between the real world problem, the technology and methods, the inter-human team relations, and the individual behaviour and performance.

3 The Spin model for teams, a forefront model

The Spin model for teams is a team dynamics model based on behavioural science, presented in (Sjøvold, 2007), (Sjøvold, 2011), and (Sjøvold, 2013). The main concepts in the model are team dynamics, individual behaviour patterns, the Level of Purpose (LoP) of the team, and the context of the team. The Spin model is based on team building and team models resulting from 70 years of research. The main tool for instrumenting the Spin model is SPGR: Systematize Person Group Relations. The tool is well validated and have been used for analysing over one million team members in their team context. A main difference from many other widely used models, is that the Spin model does not focus on personality, but rather on context dependent behaviour. A person will typically adapt behaviour strongly to the context of the team, and this can both be changed and trained, as opposed to the much more stable personality. The tendency to focus on people's personality, and based on this to assign roles to individuals in a team, has in fact proven to establish stigmatized behaviour, limiting the team dynamics and also reducing the potential for the team's LoP. Implementation of the PBL program include the use of SPGR.

3.1 Behaviour in teams

The Spin model includes four behaviour regimes: Nurture, Control, Opposition and Loyalty. In the spectre of Nurture type behaviour, we find both supportive, compassionate behaviour, and also more spontaneous ad hoc behaviour, that can create some uncertainty and distraction from the task solving team. The Control regime spans from authoritarian instructions to directed and proactive engagement for solving the tasks. The Opposition behaviour regime contains a series of obstructive behaviour, like resignation and irresponsible disregard and unfriendly stubbornness. The Opposition regime also contains useful behaviour for some occasions, like constructive protest. A certain portion of self-centred assertiveness can also assist constructive team dynamics towards top results, given that it is applied with proper timing and care, and in a responsive team culture. Loyalty behaviour is e.g. quietly performing the work agreed upon by the team.



a) b) c)

Figure 1: The Field Diagram from the spin model for teams, displaying examples of teams with different behaviour patterns. Each circle represents one individual; the behaviour is as perceived over some time.

We use diagrams (see Figure 1) from the Spin model to display measurements of the team behaviour, both on the individual level and for the team as an assembly. In the "Field diagram", we can display a collection of team members in terms of the behaviour perceived by their team mates. The position of the resulting circle for a particular person (the grey circles in Figure 1) is the result from adding eight vectors of different types of behaviour, based on 24 questions about how the person is perceived by the respondents. We show some examples in figure 1a. Individual no 1 (circle labelled 1 inside figure 1a) displays an equal mix of the three behaviour types Control, Nurture and Opposition. The small size of the circle implies that the person scores high on Loyalty, indicating that he is not very strong in any type of oral or pro-active behaviour; he will not be a very noticeable member of the team, other than the results of his work. Person no 2 has a strong tendency to act with a lot of empathy, and his behaviour is unbalanced in the sense that he is very little task-oriented. Person no 3 has a good balance between Control and Nurture behaviour, but shows no behaviour of the Opposition type, and is not very visible in the team (small circle). Team member no 4 is very noticeable in the team (large circle), and has a strong tendency to authoritarian behaviour. Person no. 5 has a good balance between all four types of behaviour. In fact, this is the average behaviour pattern when approximately 400 successful Norwegian managers were evaluated by their surroundings. It is referred to as the "norm" of constructive team behaviour. Finally, the team member in position 6 is in a resigned state. His oppositional behaviour is very silent (small circle), and the person is probably not taking much part of the team as such. He is typically silently annoyed with everything that is going on, without any visible attempt of improvement initiatives. In the case example figure 2d and 2e, nuances of observed behaviour patterns for the regimes Control, Nurture and Opposition can be seen in the text outside the circles.

Analysing teams by measurements as described above, can lead to many hypotheses about the team. In some teams, the team members display a balanced spectre of behaviour, with a good mix of Nurture, Loyalty, Control and Opposition. In other teams, some members tend to favour or disfavour a particular regime of behaviour. A misbalance in behaviour pattern will often affect the effectiveness or effectivity of the team, changing the potential team results.

Figure 1b displays a team split in two subgroups. One subgroup claims that the rules are clear and do not leave any room for discussion, and that the work should be carried out straightforwardly without any discussion. The other subgroup finds the first subgroup too authoritarian, and wants to discuss the matter thoroughly, presumably irritating the first subgroup with a need to take another round on listening to everyone in this discussion. Intrigues, inconclusive discussions, inefficient communication, poor working atmosphere and lack of synergy-creating collaboration may be the result if the polarization is a sustained

condition in the team. Finally, figure 1c displays a situation where most of the group members display an assembled behaviour with a proper balance between the different behaviour regimes, and everyone participates. The exception is the outlier, referred to as the scapegoat. The rest of the team will often blame that separated individual for any problems or mistakes in the team, and the situation will most certainly discourage and inhibit optimal teamwork. This situation is sometimes a systemic problem, rather than a particular difficult individual, but this is often not realized. Some very active team members may dominate the dynamics of the team, at the risk of suppressing others. The passive members may then display too much behaviour in the Loyalty regime. Having one or several passive members in the team often comes to the expense of effectivity and quality assurance in the group. The quality of the management behaviour can also be analysed by combining the manager's position in the group picture with the group's (varying) view of the manager's behaviour versus his/her view of own behaviour. The consensus, or lack of such, in the view of how well the group is functioning as a team, is vital information for the team developer.

3.2 Team Level of Purpose (LoP)

The Spin model for teams includes many useful terms, including the team Level of Purpose, which expresses the adaptive capability of the team. We briefly outline the concept here. The Spin model states that the more all team members are capable of flexibly varying their behaviour range, the more mature the team will become. Training the team members, and the team as an entity, on desired behaviour is therefore an important part of the team practitioner's activities. The required LoP is determined from the complexity and variation of the tasks the team is going to solve, and from the complexity and instability of the context inside which the team operates. These factors determine the required LoP for the team, and the idea is to develop the team's behaviour skills and maturity to at least match the required LoP. The LoP is a continuous variable, and the model outlines four LoPs as examples that characterize groups working with very different behaviour patterns. With increasing maturity, they are: *Reservation*, *Team spirit*, *Production* and *Innovation*. No team will operate on one distinct LoP all the time; this will vary with the tasks and with time. The team will ideally only perform high-level dynamics when needed and may, if they work under stable conditions, perform simpler dynamics most of the time. The main point is that the team needs to master the LoP required by their context, and that this level is evoked when encountering challenging situations. The LoP concept provide possibilities for analysing, evaluating and suggesting improvements and training towards the level that fits the requirements for the team context.

The Reservation team LoP is also called an "I"-dynamics group. In this lowest of the LoPs, everyone focuses on themselves and on the contribution delivered from me to the group, or just directly to the team leader. Most members show a very restricted spectrum of behaviour, and typically, everyone masters the "Nurture" type of behaviour. In these teams, we will often observe a clear division between individual's roles. The Reservation team is efficient and effective if the tasks and context are highly predictable, particularly if management is performed with strong control, often in an authoritarian style. It is a prerequisite for success that the job is well defined, preferably with strict rules and standard operations that can be trained by drill. These teams do not have the dynamics required for improvements, and they are very fragile to external pressure, internal disagreements and changing conditions.

The Team Spirit LoP is termed a "we"-dynamics group, where all team members share a common responsibility for the team to obtain its objectives. The members are proud of their group, and they often view the team leader as a hero whose opinions are seldom questioned. The team leader usually directs improvements, if there are any. In addition to "Nurture", all members need to fill the "loyalty" type behaviour, sharing and helping the other team members and doing as they are told, and preferably not asking questions

on the way they work, or on the leader's conclusions, or the way things are managed. The team often sees itself as complacent, and superior to its competitors, not taking many ideas from the outside, and the members often show a sceptical, or even hostile, view on other groups or external suggestions. The Team spirit group is result oriented and can be efficient under stable conditions, when the task is not too complicated, and it requires full mobilization of everyone's resources over a short time. The team spirit group needs serial short-term successes in order to keep up the spirit. The work is often regulated by procedures and standards, and the team will normally not challenge them by own initiative.

The Production team LoP is also referred to as the "us"-dynamics. The group is not as efficient as the team spirit group, but the team members can work patiently over longer periods towards a future target. An inherent ground rule is that it is fully acceptable to question the way they perform their work. The team members are encouraged and helped by colleagues in order to achieve success for the group and for the company. The Production team extracts much of its energy from open discussions on how the work can be improved and performed with better results. The demand for ideological leadership is no longer prominent, and the management style is open, democratic and inviting. The behaviour pattern is now more adaptive for all team members, and all members master each behaviour type, usually with the exception of constructive opposition. The team is quite adaptive, unless changes in the context are dramatically abrupt.

The Innovation team LoP is termed "Free flow" dynamics. This represents the highest LoP in these Spin model examples. An Innovation team is capable of creating genuinely new modes of working and of developing abrupt innovations in products, processes and concepts. The group dynamics enable a natural curiosity of the outer world, how things are done there, and how the world is developing. It is fully acceptable to question the group's status quo and its reason for being. The membership of the team is inherent for each member, even if he or she leaves the group. There is no need for a leader in the classical sense. Every member is pro-active, and claims similar attention in the team. All team members master all behaviour regimes, and in a discussion, the behaviour pattern may change so rapidly that it is hard to determine which regime the team is operating at a particular time. In most cases, it will not be appropriate to develop an Innovation LoP in a Lean production group. Firstly, because it may be wasted efforts developing this high level, and secondly because lifting a group to Innovation involves a risk of generating instabilities in the team. On the other hand, the Innovation level may often be the optimal LoP for a leader group in a challenging business. These statements are indicative, however, and we need to consider each case while analysing the context, the stability of the surroundings and tasks, the individuals in the group, the nature of the tasks, etc. Note that research has shown that a team that are able to work on a high LoP can also be able to work on lower LoPs when required, but that this require training also on the lower LoPs, as well as awareness of these aspects.

3.3 Team building

Optimizing the performance of a team inside a particular maturity level is termed "team training". One of the main aspects of the Spin model for groups is the strategies for lifting a team from one LoP to a higher one. This process is termed "team development". Note that the Spin model flags some warnings on risks that may damage the teams in the team development process.

Many team-building agents use personality as the basis for analysis and for distributing roles in the team. It is vital to understand that the Spin model for teams addresses behaviour and the development of behaviour, which opens up large new perspectives for the team LoP and dynamics. Furthermore, many team builders work by taking the team out of its normal context and create events and experiences on new arenas. According to the Spin model for teams, this may be pleasant, frightening or inspiring, but research suggests

that the possible learnings won during these events, are hard to transfer to relevant and sustainable competences in the normal working context. Team building will therefore be much more efficient when performed within the normal scope of the everyday work.

The team that aims at a high LoP needs to discuss regularly their strategy and general dispositions. A professional team should establish effective procedures to initiate and apply improvement projects. A democratic and involving process for goals and evaluation must be facilitated. We need to develop a culture where the capabilities of the members are utilized in an optimal manner. The team establishes ground rules, where suggestions for improvement are not only accepted, but also encouraged. The team leader must facilitate true teamwork where everyone seeks success, not only for oneself, but also for the other team members, for the team and for the organization. The team manager is responsible for creating arenas and bridges to the rest of the organization. This includes exchanging expectations, asserting that each team member understands their part of the larger game, in which the team in all manners aligns with the company, and that proper communication is flowing freely in the larger scope, like e.g. the company. Criticism and scrutiny is accepted and encouraged, and there are few lasting conflicts. The high LoP team takes action if individual members avoid their responsibility of tasks in the group or alignment towards the organization. The team is trained in broadening and adapting their behaviour pattern. Moreover, the ambitious team can be trained in accepting that continuous improvement is vital for success. In order to achieve this, we work both with culture, team LoP and behaviour patterns on the individual level and on the team level. The team is trained to evaluate itself whether they are properly aligned with the organization values, goals and improvement processes.

The information from the team analysis on behaviour and LoP can establish hypotheses on potential improvements for the group towards a suitable result. As team coaches, we then discuss and reflect upon these hypotheses in a feedback session with the team. The Spin model provides a language, by which the symptoms and consequences of non-optimal team behaviour can be detected and discussed. The team can investigate root causes to the team issues, elaborating possible solutions and select the best one.

4 The 2016 PBL course implementation

Veidekke is one the biggest contractors in Norway and is known for their focus on cooperation processes and their focus on the importance of “social interaction”. Veidekke has been an important cooperation partner for this work and has exemplified how to be aware of “social interaction” challenges in projects and how challenges can be solved.

Veidekke has divided their project performance platform into phases “early stage”, “implementation phase” and “operation phase”. For the “early stage”, we know that is difficult to predict the performance process. The “implementation phase” is expected to more predictable but in reality this is not always the case. Experience in Veidekke shows that even if similar jobs have been done many times before, circumstances lead to ambiguity for different process paths, which in turn lead to different cost, time and resulting quality.

They use a process called “obstacle analysis”, with 6 topics that need to be addressed: 1. Project basis. 2. Expectations and requirements. 3. Degree of dialog. 4. Decisions. 5. The team skills 6. Methods and tools.

4.1 The student cases

The students were assigned cases, one for each team. The team size has varied from 3 to 5 persons. It is important that the cases are so challenging and so interesting that the students are motivated to use the

whole spectre of skills, knowledge and instincts to solve the tasks in addition to the "pass/not pass" criteria for the subject. The challenge is divided in 2 stages:

1. "Early stage". The students have 4 weeks where they have to come up with a concept on a challenging problem.
2. "Implementation phase". The students must then make a plan for the last 4 weeks.

The expectation is that the students should produce more, and be more efficient, in the "implementation phase" than the creative "early stage" phase. The "obstacle analysis" is something that for Veidekke takes place all the way through a project. It is interesting to observe whether this is the case for the student teams.

The team assembly is made by random, and the students of 2016 were divided into 24 teams. The teams were assigned realistic problems concerning the city of Trondheim or surroundings. The case list of 2016 contained different cases, e.g. a local railway circle line, several local freight terminals, a wind turbine park, local transport, the concept of Trondheim centre without cars, floating concrete buildings, and several bridge projects. The assignments are divided into three main areas: "City themes", "Rural themes" and "Marine themes". In parallel with the specific content of the projects, the student teams all assess themselves by the SPGR group dynamic tool, and reflect on the group dynamics, the group interaction, and the work processes that led to the group understanding, results and deliverance. During the nine weeks of work, they are assessed by SPGR in weeks 3 and 7.

There are some typical issues that repeatedly occur in the teams, that can be observed in a combination of SPGR data and students own observations, and that can be improved. Below, we mention some examples.

One typical situation is that some students are less proactive, and less dominating in the team, seen as small circles in the Field diagram. They are often contributing by loyally doing what is agreed, but they do not take out their full spectrum of potential team contribution.

A typical situation is a team where one or several of the members are separated from the rest of the team in the SPGR Field diagram. This was described as either "polarized team" or "scape goat" in section 3.1. The team should discuss whether this is recognized in the team behaviour, and whether this represents a decrease in effectivity and effectiveness. In some cases, it is discovered that the division is not real, but rather perceived by many group members based on prejudices or beliefs. These issues may be reduced, or even removed, by discussing common expectations and work procedures.

Are all team members displaying constructive team behaviour over time? This is represented by being inside the circle sector that is marked by yellow on the circle circumference. Research show that behaviour perceived outside this sector persistently over some time is inhibiting effective and efficient team work. Note again that this is not necessarily the subject team member's own fault, but should rather be seen as a system flaw for the group to solve collectively. And note also that the behaviour is subjectively perceived in this manner by the group, which may have many subtle root causes based on the collective team culture. It is also interesting for the group to check whether they act assembled with a behaviour pattern separating significantly from the balanced behaviour expressed by the "Norm" mentioned in section 3. If the group has a tendency to act with too much/little Control, too much/little Nurture or too much or too little Opposition, this may well result in a non-optimal effectivity or non-optimal efficiency for the group work.

In general, it is interesting whether the team members recognize the behaviour patterns displayed in the SPGR diagrams, and whether the team members report similar behaviour patterns, or if they describe the

team quite differently in the measurement. This will often lead to very useful reflections and changes towards common expectations and common views on effective group processes.

Finally, it is useful to discuss which Level of Purpose that is suitable in the two main stages in the team work, and how this is reflected by the actual work mode displayed in the group. If the team acts with a low Level of Purpose in the early stage of the project, the result may be that the group misses many opportunities in exploring and developing creative solutions that may be more effective than the straightforward one. On the other hand, if the group continues to behave creatively and discussing and scrutinizing the work methods they use, i.e. operating on a high LoP during the last stage of the work, they risk not being able to finalize their project in time, or they are forced to land abruptly on poor quality and lacking elements in their results.

Although much can be achieved by the students with their own reflections and discussions in the team, the result of the Bildung part will be strongly enhanced by the guidance of an experienced SPGR coach, and by objectivity checks by an external observer, commenting on the team behaviour, and on the team's own evaluation compared to what the observer himself observes in the team performance. The teacher can take this role for the student teams.

5 Discussion and lessons learned

5.1 Discussion

The teams are selected and assembled by the teacher. This means that some students will feel that they have been let down by destiny, stuck with team members they either did not like in advance, by prejudice, or that they by first appearance perceive as someone that they do not like to collaborate with. First experience meetings create all sorts of stigmatisation, and with so short a working period, there is little time and motivation to straighten out these conditions. For some, this experience works well, and everything goes along a smooth line of project work. We can see this from their SPGR measurements, and by their final report, where they describe a good process with nice behaviour and positive collaboration. For some, the road is more than bumpy, and first impressions and different expectations, and perhaps perceived unclear instructions from the teacher, creates poor team collaboration, somewhat chaotic and slightly anarchistic – in the worst cases – behaviour, on a low team maturity level, where it is everyone for themselves. And some of them stay there through the process. The most interesting type of group is those that had clear problems in the beginning, but where the SPGR reflections obviously displayed to them some challenges, and where the discussions and clarifications made a change, and they worked more constructively and more mature in the second part of the work.

However, the groups for the first year appeared mostly to fall into one of the two first categories, and there was little change between the first and the second assessment. This is an interesting observation that require further comments, but also further work. The reason might be that the stigmas created in the group in the beginning led to static conditions that were either "good" or "poor", depending on the first notes, and on the motivation of the team members. Another reason might be that the groups that really needed to improve would have benefited strongly by closer follow-up by an experienced team coach, and that they did not manage to change although they observed some team challenges – or perhaps they did not even realize that there were problems, which again could have several reasons. A third reason for no positive change in some groups might also be due to poor motivation for the course, the project results, and for doing the job with improving the team. For some it may not seem to be worth the efforts it would take, and for some, they lack the human relation tools and experience to overcome the problems that inhibit better team work. A two

hour class on team relations do not suffice for creating good team toolboxes. For some, the project served as a good training arena, and for some it didn't.

On top of this, most groups will have a need for a change of pace from the first to the second stage in the project work. The LoP will as mentioned need to go from high to low. The creativity will have to be surrendered in order to give way for the goal oriented work in the final period. This challenges the team further, urging them to being able to modify their behaviour balance between the stages. This is actually the true definition of team maturity: to be able to balance the behaviour assembled by the different behaviour types, adapting to what is required appropriately in the moment. A proper team maturity demands knowledge of these things, proper training and good common reflections on these issues. A better awareness of this from both the students and from the teacher needs to be a continuous focus, in order to succeed with the Bildung for as many as possible of the students.

Simmel (Simmel, 1955) showed already in 1955 that team over 5 person's use more time on coordinating activities than production. Student teams of 3 to 5 persons is therefore a good choice. When the number rises to three persons and upwards, synergy effects, relation effects, communication and possible conflicts increase rapidly. This should mean that the more, the merrier - but also the more, the more complex and challenging. It is expected that groups of three demand more motivation and member qualities in order to create synergies and enhancing interaction. The relational part may not be as straightforward to understand as one could expect. Because although three persons is less prone to conflicts due to the low number of relations involved, it is also vulnerable to e.g. the effect of shyness, group think and relational based inhibitors. The last point means that if they match each other's behaviour dynamics well, three persons can be very effective. However, in the opposite case, three persons can probably be very inefficient if they enter a negative spiral of e.g. red (Opposition), grey (Loyal) or green (Nurture) behaviour, lacking the blue pro-active part that drives progress and results. It could be expected that four or five team members would be less vulnerable to such effects. Though we have not studied these effects in the programme, the group size of 3, 4 or 5 is an interesting parameter that could be investigated further in this particular programme.

5.2 Lessons learned

Summing up, we start with a clear observation that this programme is useful for the students' Bildung and understanding of relations in teams, the importance of the work processes in teams, and that training is very important to develop good understanding and skills in team project work.

We also conclude that the process draws the students out of their comfort zones, and that frustration is a word that often surfaces when the students report the project processes. The assignment is complex, as it addresses both scientific, analytical, work process and relational skills and issues. Frustration may be positive to release understanding and learning, but if a line is crossed where confidence towards the fellow team members or towards the teacher is broken, the learning effects may easily evaporate. One major key factor here, is that the teacher must have time to coach the processes to a certain extent, and to enter the team processes with interventions or strong counselling when a group is on the way into anarchy or chaos.

Communication, scope, rules and advice should be communicated clearly in the initial phase of the processes, and the students should be tutored on basic team relation models in the beginning of the process, in order to have tools to evoke when needed in the process.

The ideal for the initial stage is the *innovation* Level of Purpose, where the students should understand the problem fast and be innovative, questioning their working methods and even their *raison d'être*. In the final

stage, the Team Spirit is probably the best level to work in, working in positive synergy without questioning the methods. In practice, the student groups will often start out in the *Reservation* level, improving into elements from the higher levels, without mastering fully the aspect of those. Much of the time, the best groups will work within the *Team spirit* level. Even if the effect of the exercise is limited, in training the teams to operate inside all these LoP's, it is possible for the teacher to explain what the levels are about, and what the students can do to improve. One of the major effects of this PBL exercise is that the students experience these circumstances and understands the challenges and the ideals. It is feasible to coach the students based on what they have done, things they could have done better or worse. The awareness of how social interaction works under different circumstances has been improved. Hopefully this is visible when they later work in multidiscipline and complex projects with many people, and also in simpler projects with less people. The students have got a basis and some tools for handling these challenges – **and this is Bildung:** The students have developed competence with respect of project performance processes, teams and cooperation skills and done reflections around development of concepts which is important for the society to solve. It has been a clue during the process that the students have to do their own judgements. The students are encourage to be critical and use trust their stomach feeling in discussion and decision processes. With positive feedback based in what they have produced hopefully the society will see that they have got more adaptable and prepared for a more unpredictable world.

And finally, we will make a claim, that the Bildung is an underestimated part of the students' education, and that the current PBL engineer course is a step in the right direction, but that subjects like team relations, effective work processes, behaviour dynamics, constructive confrontation and conflicts should be given far more attention in future educational programs.

References

Sjøvold, E. 2007, "Systematizing Person-Group Relations – A Field Theory of Social Interaction. Small Group Research, 38(5), See also http://www.spgr.no/institute/?lang=en 12.

Sjøvold, E. 2011, "The Team", lectures in MTM course, Røros February 2011 13, unpublished.

Sjøvold, E. 2013, "The Spin-theory of Group-dynamics and its Operationalization, Nesodden: SPGR publishing

Barrows, H.S. and Tamblyn, R.M., 1980, "Problem-based learning: An approach to medical education, (Springer Series on Medical Education, Vol 1), Springer Publishing Company

Tuckman, B.W., 1965, "Developmental sequence in small groups 1, Psychological Bulletin, 63(6), pp 384-399

Simmel, G., 1955, "Conflict and the web of Group-Affiliations". New York: Free press. 125-95.

Lovdata, 2011, https://lovdata.no/dokument/SF/forskrift/2011-02-03-107

The Bildung Committee, 2010, http://www.uib.no/node/49551 and
http://www.uib.no/filearchive/innstilling-dannelsesutvalget.pdf

Jon Hellenes 1969, Pedagogikk og samfunn, «Ein utdanna mann og eit dana menneske»

Klafki, W. 2001. Dannelsesteori og didaktikk. Nye studier. København: Klim forlag