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Häme University
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**PRACTICAL HANDBOOK OF
PROBLEM-BASED LEARNING**

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Practical Handbook of Problem-Based Learning

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Preface



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The Practical Handbook of Problem-Based Learning collection provides insights and hands-on tips on how to implement problem-based learning (PBL) in practice. PBL has long been recognised as an efficient teaching method to deliver so called soft skills, also referred as 21st century skills and core competencies, to students. There is vast academic evidence on the beneficiality of PBL. Yet, academic results do not automatically transfer to practice. We have noticed that many educators are willing and enthusiastic to practice PBL, but the change from traditional teaching methods to PBL is not easy. Many educators are left puzzled how to actually implement PBL in their classroom. To ease and facilitate teachers to practice PBL in the first times, this collection provides pragmatic, hands-on examples on PBL implementation.

The collection is produced as part of the EU-funded 21st Century Climate-Smart Forestry Education for Livelihood and Sustainability in South Africa (FOREST21) project, that promoted climate-smart forestry and entrepreneurship education in South African forestry higher education institutions. Introducing problem-based learning was a key component of the project. The FOREST21 project run from January 2021 to January 2025.

This collection, with all its articles, has been originally published in HAMK Unlimited Professional (<https://unlimited.hamk.fi/professional/>). The articles have been modified from the original source by adding an abstract to each article, and the heading title “introduction”.

Helsinki & Hämeenlinna, Finland

5th March 2025

Satu Määttä

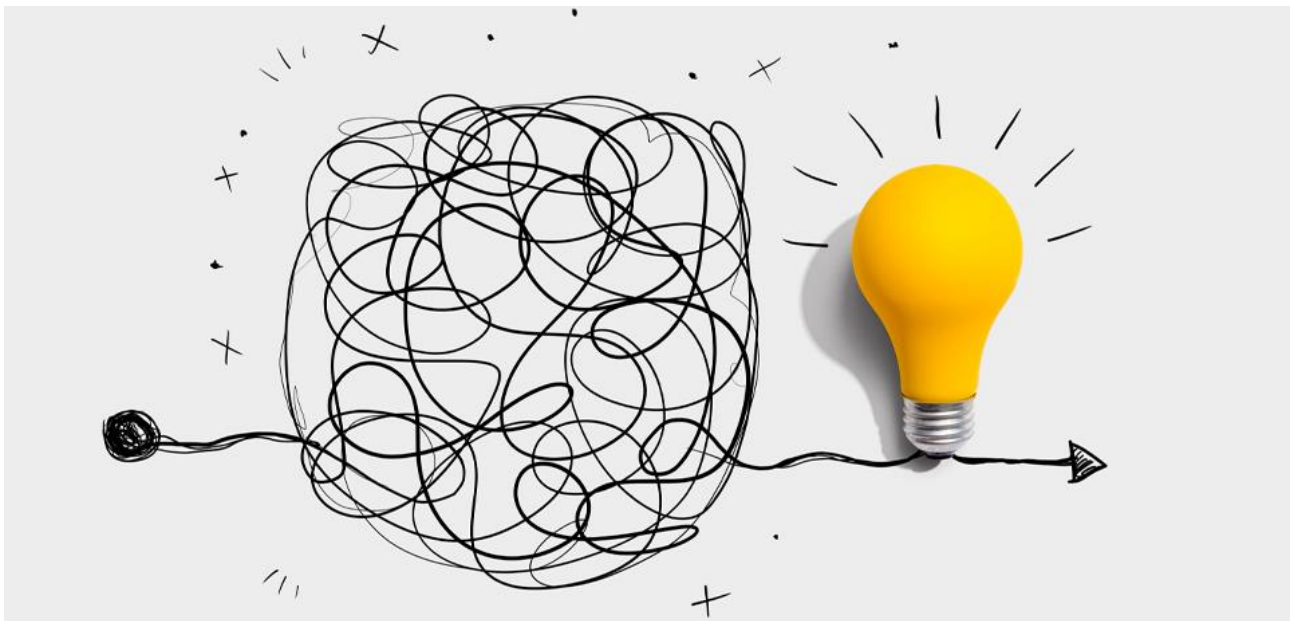
Ulla-Maija Knuutti



Navigating problem-based learning cycle: Teacher's and student's perspectives

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ABSTRACT

World of work competencies extend beyond content knowledge, requiring a range of soft skills and transferrable competencies. Problem-based learning (PBL) is an effective method to deliver these core skills, such as analysis skills, creative thinking, and teamwork. While PBL has been widely studied, and the theory and benefits are thoroughly documented, transferring the theory into practical teaching is easier said than done. This article presents the PBL cycle from both teacher's and student's perspectives, providing a pragmatically oriented approach on how to implement PBL in practice.

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INTRODUCTION

Relevant competencies in the world of work are much more than just content knowledge. To be able to solve current and future problems, contribute to societal development, innovate, and add value, it requires a wide range of soft skills and transferrable competencies. Problem-based learning (PBL) is acknowledged to be an effective method to deliver these “core” skills, such as analysis skills, creative thinking, and teamwork skills, to students (e.g. Abbey et al., 2017; Ding et al., 2014; Filmer & Fox, 2014).

The theory and benefits of PBL are widely presented in academic and professional literature. However, converting theory to practice is easier said than done. PBL emphasises the students’ responsibility and active role in the learning process and sees the teacher mainly as a facilitator of the learning (Weimer, 2002). This, however, does not mean that the teacher is let off easy. On the contrary, PBL requires much thought and work from the teacher, it just differs from the traditional mode of preparing slides, lecturing, and grading exams.

In this article, we present the PBL “cycle” from both the teachers’ and students’ points of view, but with more emphasis on the teacher. The article is based on the first-hand experiences of the main author of the article.

THE FULL PBL CYCLE

The PBL cycle, i.e. the phases to implement PBL, is, in most cases, presented from the student’s point of view, focusing on what the students must do during the learning process. This, however, provides only a partial picture of the actual process of PBL, as it leaves most of the teacher’s work invisible. The “full” PBL cycle, from both teachers’ and students’ perspectives (Figure 1), can be categorised into various phases and responsibilities, represented below with teacher

responsibilities marked with (T) and students’ with (S).

1. Pre-planning of the learning process (T)

This part of the cycle takes the bulk of the teacher’s time and resources but makes the rest of the work easier. We can guarantee that the phrase “Well planned is half done”, is completely true in PBL.

For easier digestibility, the pre-planning phase can be divided into various sub-tasks: (i) Familiarising with the learning outcomes, as it all starts with the curricula and the predefined learning outcomes: What kind of competencies the students are supposed to learn? (ii) Creating the problem scenario. Whether by the teacher alone or with an external partner, defining a real-life challenge situation that will be the starting point for the students’ work: What kind of challenge would motivate the students and guide them to work towards the learning outcomes? (iii) Ideating the student exercises/tasks and planning the course timing. Designing different tasks for the students to provide structure and timelines for the learning process: What kind of tasks would assist students in developing the desired learning outcomes? (iv) Creating the evaluation framework. Planning, how, when and based on what the students will be assessed and evaluated, and what tasks or outcomes you are emphasised to demonstrate the achievement of the learning outcomes.

After everything is planned, the teacher is set to go. It’s time to start the course.

2. Creating a safe learning environment (T)

The Teacher starts by creating – and after maintaining – a safe and open learning environment that facilitates creative thinking, team spirit, and learning. It is also advisable for a teacher to present him/herself to students without being too formal. It

encourages students to turn to the teacher when they need help.

3. Building the teams (T)

The teacher divides the students into functional teams, paying attention to the student characteristics and team size (Määttä et al., 2022). The student teams should be provided with tools and tasks to get to know each other and to build trust.

4. Presenting the problem scenario (T)

The teacher presents the real-life challenge situation and its background to the students.

5. Identifying and defining the problem (S)

Based on the problem scenario, the students isolate and define an individual “problem” or a “case” they want to work with.

6. Facilitating problem identification (T)

The students may feel overwhelmed by the problem scenario, and no wonder, in real life, challenges are chaos(es). The teacher should help students and student teams to break down the problem and find viewpoints interesting to them.

7. Understanding the problem and team competencies (S)

Students map the existing team knowledge and competencies, define team roles and responsibilities, and identify what kind of knowledge is needed to develop solution(s) to the problem.

8. Facilitating team meetings and information acquisition (T)

The teacher should not tell students what to do or lecture them. Instead, the teacher is recommended to ask guiding questions; *“Did you consider this...”*

9. Acquiring knowledge and applying it (S)

Students acquire knowledge and data from various sources. Students share the acquired knowledge and insights within and among the teams. Students apply the acquired knowledge to develop solutions to the problem.

10. Facilitating knowledge building and application (T)

The teacher facilitates the student team meetings and provides platforms/sessions among the teams to ensure knowledge sharing. The teacher should not lecture but allow the students to teach each other, innovate and provide guiding questions if needed.

11. Presenting the results (S)

Students present the developed solutions orally, in written form, or by some other means. Presenting is also a part of the learning process, as teaching others is one of the most efficient ways of learning.

12. Emphasising the learning process (T)

The teacher should provide students an opportunity to practice communication skills by presenting their solutions. It’s important to remind the students – and the teacher, too – that the process is and was about learning, not the final output.

13. Self-reflection (S)

Throughout the cycle, students self-reflect their learning.

14. Assessing and providing feedback (T)

The teacher assesses and provides feedback to students throughout the learning process, as well as methods and tools that aid students’ self-reflection. The teacher should also assess and evaluate him/herself and the learning process performance. What worked well and what not? What could you do better next time?

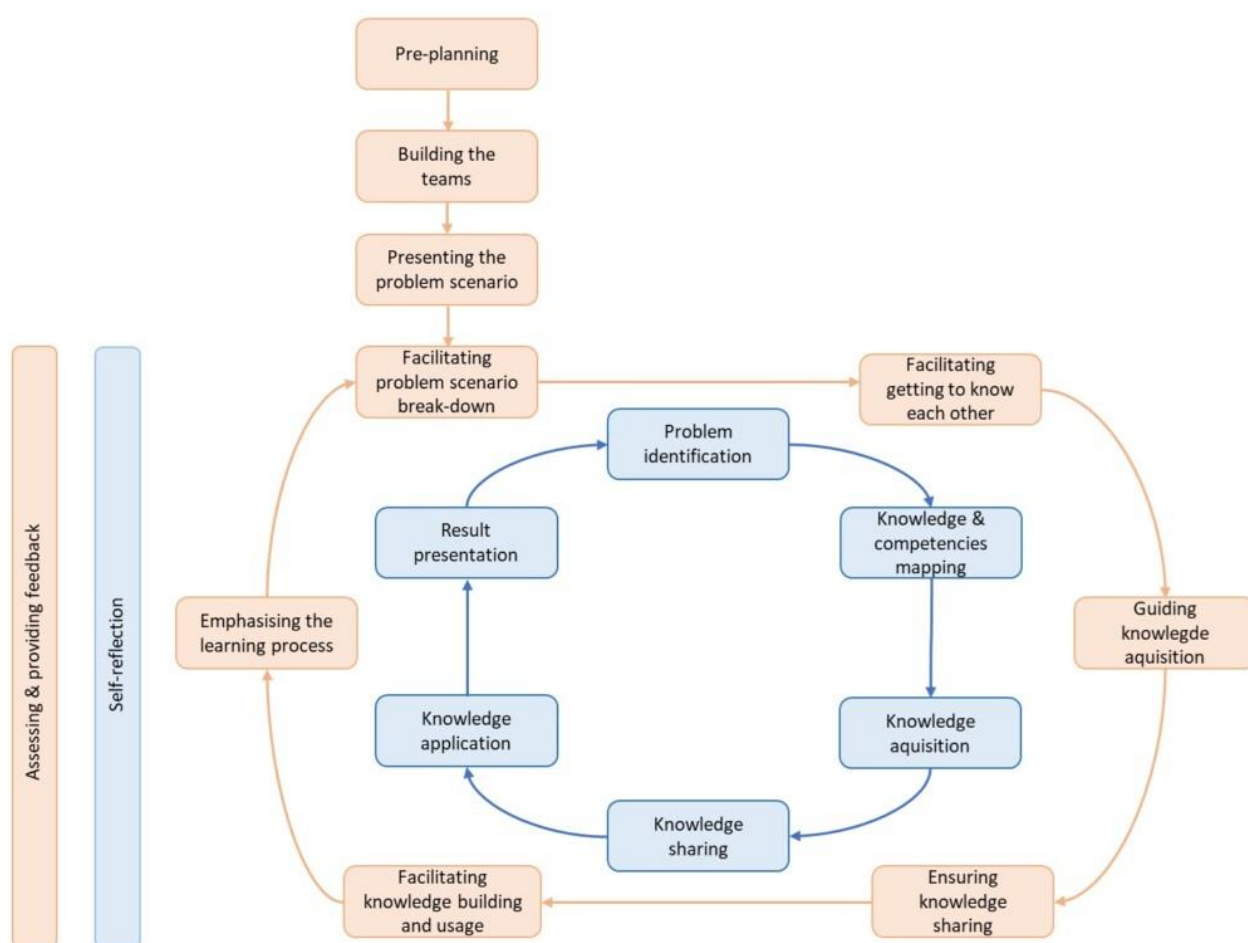


Figure 1. Schematic illustration of the PBL cycle from the teacher's (red) and students' (blue) point of view.

It is important to understand that in the real-world setting, the PBL phases do not follow each other neatly and linearly, but the students, and thus, the teacher also, will bounce from one phase to another. This is why teachers in PBL need to cope with chaos and messiness (Weimer, 2002). We also want to emphasise that the students' and teachers' phases occur parallel rather than linearly, with the teachers constantly facilitating students, being ready to improvise and change plans if needed.

FAIL, LEARN, AND TRY AGAIN

We understand that implementing PBL, especially for the first time, is not easy for the teacher despite how many guidebooks there

are to help. Thus, don't be afraid of failing. On the contrary, consider yourself lucky if you fail, as that is the best way to learn and improve. Analyse the shortcomings and pitfalls by yourself and together with the students and learn from them.

The more familiar you get with the practice, the more you will succeed. After some time, facilitating PBL comes as much of a routine for you as giving lectures. Maybe after a few years, you will be the one writing PBL guidebooks, based on your experiences, to help others.

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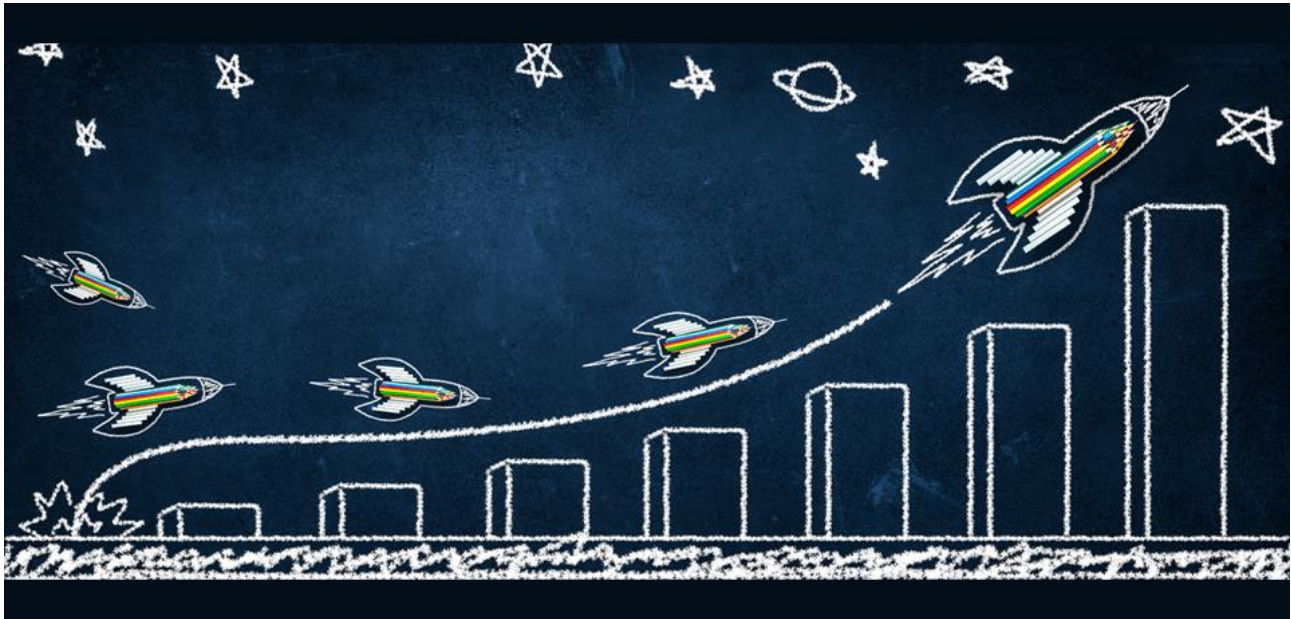
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How to orientate students to PBL

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ABSTRACT

While problem-based learning (PBL) is praised for its various benefits, such as developing core 21st-century competencies, and increasing motivation, transferring to PBL in the first time often causes resistance among students. PBL requires a mindset and behavioral change within the students and this change can cause feelings such as anxiety and stress. Yet, when students get accustomed to PBL, they tend to start liking and preferring this teaching and learning method. This article provides practical tips, on how teacher can initiate students to PBL, shortening the time of initial student resistance, and foster a learning environment conducive for learning.

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INTRODUCTION

The literature on problem-based learning (PBL) mostly praises its various benefits, such as the development of transferrable, 21st-century competencies, increased student motivation, and reduced drop-outs (e.g., Abbey et al., 2017; Ding et al., 2014a; Tan et al., 2014). Thus, one would assume that students, the main beneficiaries of the PBL method, would thrive on converting to this practice from the passive lectures.

The reality, however, is often the contrary. PBL requires both a mindset and behavioral change from the students and this may, and often will, cause anxiety, stress, and even resistance among students. This is especially the case with students practicing the method for the first time. Usually, the more familiar the students get with the method, the less it will cause negative feelings (Abbey et al., 2017; McCowan, 2018; Weimer, 2002). The students tend to prefer and like PBL when they get accustomed to their new, more active, and responsible role.

In this article, we provide practical tips, based on our own experience, on how to orientate students to PBL, reducing the time when students feel frustrated and resistant toward the method and are even afraid of it.

CHANGE IN STUDENTS' ROLE AND RESPONSIBILITY: HOW DOES IT FEEL

In PBL, students become active learners, with learning driven by experiences and doing. Students need to themselves – yet, of course, guided by the teacher – acquire information, as well as assess and apply it while also finding ways to work and cooperate with other team members. This responsibility and active role may feel overwhelming to the students. Studies report students perceive PBL as more challenging, time-consuming, and more difficult than traditional, teacher-led pedagogical methods (Abbey et al., 2017;

McCowan, 2018; Weimer, 2002). The teacher's role (which is a very important one!) is to support students in the conversion to active, responsible, and self-imposed actors who can reflect their own learning needs and styles. To best understand and find ways to do that, it is important to understand how students feel.

We have asked students to anonymously express their feelings at the beginning of a PBL course (Figure 1). The most common words to describe the feelings were: "nervous," "chaotic," and "distressed," but also "excited," "interested," and "enthusiastic". The teacher should help students to let go of the negative feelings or to find strength and excitement in them, as well as emphasise and arouse positive feelings.

HOW TO SUPPORT STUDENTS IN PBL

In addition to the probably most commonly referred teacher's tasks in PBL, which is to facilitate student work in the PBL cycle (see, e.g., Knuutti & Määttä, 2024) i.e., facilitate information acquiring and applying, the teacher should also support and facilitate students' orientation towards the PBL method. In practice, this means facilitating and guiding students to identify their learning needs and the best methods of learning for them, and gain confidence, i.e., to start to direct their own learning and doing.

To help teachers in this demanding task, we compiled a checklist for teachers to guide them on supporting PBL students.

(1) Know what you are doing. To be able to instruct and facilitate PBL, you need to have a basic understanding of the method, its pedagogical background, the PBL cycle, and its basic characteristics (Abbey et al., 2017). In addition to the general theory behind PBL, you need to pre-plan your course with care. Only then will you be able to clearly state the PBL goals for the students and explain throughout the course what is happening and why and

which are the starting points for orientating students to PBL.

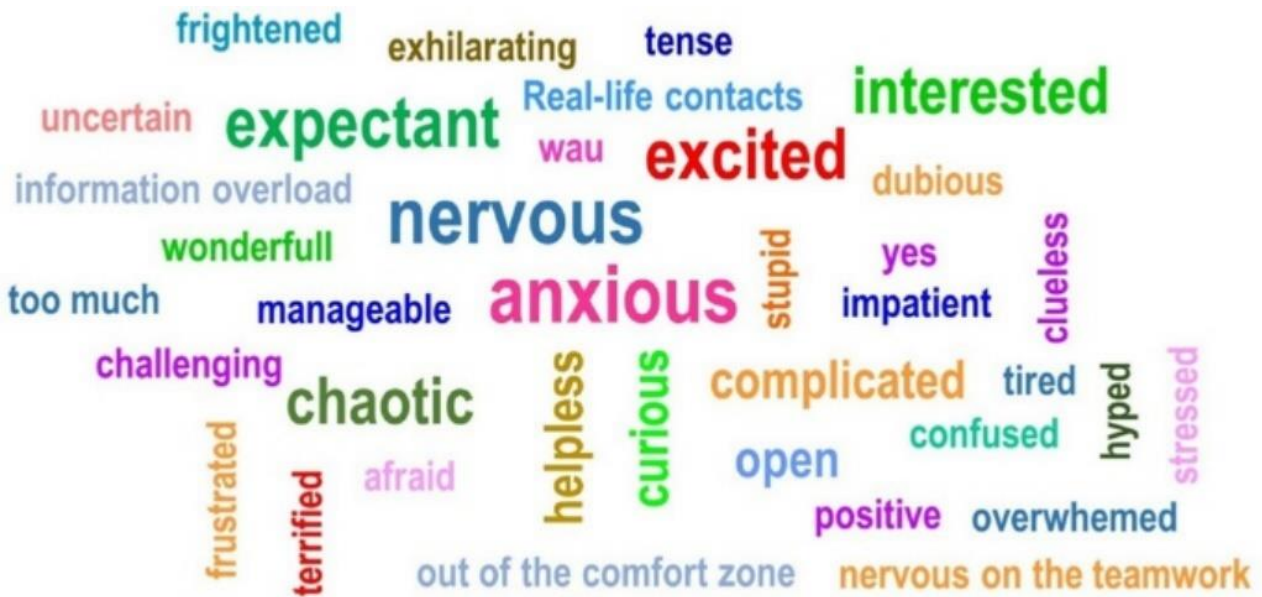


Figure 1. Students' perceptions on their feelings at the onset of a PBL course

(2) Change your mindset first. Don't expect students to change their mindset and habits if you, as a teacher, are not doing the same. It is not only the students who may feel nervous or resistant toward PBL, the exact same also applies to teachers. Facilitating PBL requires a different set of attitudes and skills from teachers than lecturing. Important characteristics of PBL instructors include patience, persistence, tenacity, and emotional intelligence (Abbey et al., 2017; Weimer, 2002).

(3) Tolerate and adapt to chaos. The PBL process is, by nature, chaotic and messy. While in theory the PBL cycle is often presented as a logical, iterative cycle, where one phase follows another, the reality is often far from that (Figure 2). The students often bounce from one phase to another in a "chaotic" order. As a teacher, you need to be able to adapt to the chaotic learning process, while continuously facilitating the students' work.

(4) Do not tell what to do. Ordering students, directing them what to or providing direct

answers will not take you or your students far. Commands often arouse and increase resistance and reduce motivation. In PBL, student autonomy and activity are vital, thus the teacher's role is to guide students through the learning process, not to tell them how to and what to learn and do (Major & Palmer, 2001).

(5) Manage the learning environment. Create and maintain a supportive learning environment that fosters openness, interactions, and information sharing among and between teachers and students (Knuutti & Määttä, 2022). Relating to learning methods, emphasize doing rather than just reading and memorizing.

(6) Persuade. Convince students of the benefits of PBL. Emphasize to them that they are learning for their future, to manage and succeed in the world of work, not to succeed in exams. You can lure out the change in students if you get them to try the method seriously. It does not matter how you get them

to try and put themselves in: you can encourage them with e.g. persuasion, social pressure, leading by example or a combination of various methods.

(7) Change the whole system. Despite being highly important and influential, teachers alone cannot make the change.

The whole education system needs to change to make PBL an attractive option for the students. Teachers need to be provided incentives to practice PBL, and so do students. Content knowledge and grade-oriented educational institutions may not be able to inspire students on PBL (Weimer, 2002).

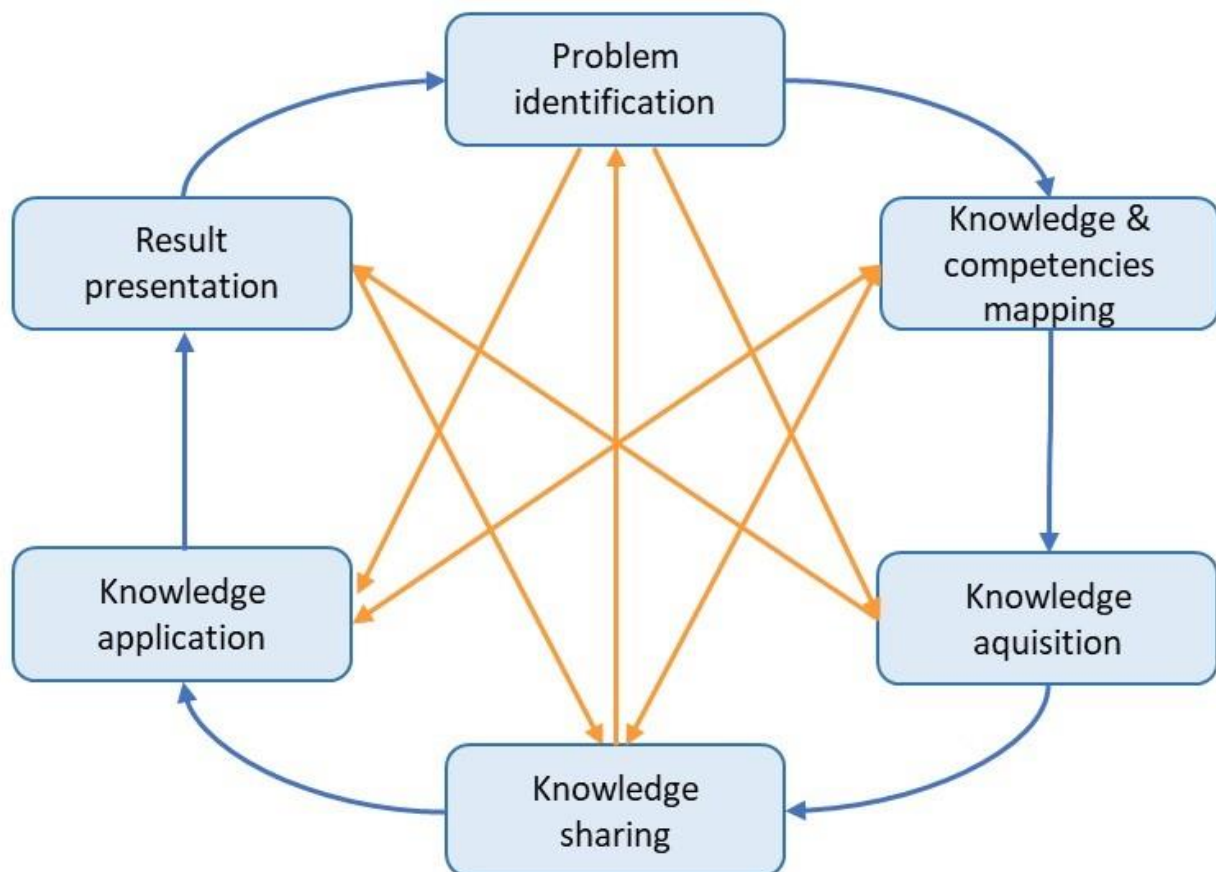


Figure 2. The PBL cycle in theory (blue lines), is an iterative cycle where the PBL phases follow each other in logical order. In reality, the students often bounce from one phase to another in a “chaotic” order (for example, with orange lines)

BE THE CATALYST OF CHANGE

Teachers have a key role in society in educating the future problem-solvers and change-makers. Appraise this demanding and yet highly rewarding task by being a catalyst of change. With adequate support, you can be able to change students’ mindsets and make

them acquire and appreciate competencies that may influence their whole careers, and societal development at large. Recognise also your role within your institution and educational governance and call out for practices and policies that will assist you in enduring your profession in the best possible way..

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Motivating students in problem-based learning

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ABSTRACT

Motivated and committed students make learning most effective. Problem-based learning (PBL) is generally regarded as a motivating teaching method due to its real-life setting and emphasis on active participation, yet there is now hard evidence to back up this assumption. Teachers can contribute to student motivation by emphasising specific aspects of learning. This article, basing on the ARCS model by John M Keller, provides practical examples with do's and don'ts on how to motivate students in PBL.

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INTRODUCTION

When students are motivated and committed to learning, teaching is at its best, and desired learning outcomes are easiest to achieve. Problem-based learning (PBL) is generally considered a motivating learning method for students as it is based on real-life settings, and it emphasises students' active participation and knowledge creation. However, studies have also reported initial student resistance toward PBL (McCowan, 2018; Weimer, 2002, p. 81), and there is no rigorous scientific evidence backing up the general assumption of PBL being automatically motivating (Rotgans & Schmidt, 2019).

Thus, to ensure or at least contribute to students' motivation in PBL, the teachers should emphasise specific aspects of learning. In this article, we provide practical examples of how to motivate students in PBL. The article draws from the ARCS model by John M Keller, and it's seasoned by the profound teaching experience of the main author of the article.

ARCS MODEL OF MOTIVATION

In PBL, as compared to the conventional, lecture-based model of teaching, students' roles change from passive to active actors. Subsequently, students are required to take responsibility for their own learning. Teachers' main role in PBL is to support and facilitate learning, which includes motivating the students. To assist teachers in this task, John M Keller has developed the ARCS model that can be used to design learning strategies and environments that revive motivation toward learning (Keller, 2012). The name of the model is an abbreviation of four categories that include motivational concepts and theories: attention, relevance, confidence, and satisfaction (Keller, 2012).

Attention refers to "gaining attention, building curiosity, and sustaining active engagement"

(Keller, 2012). In practice, this can translate to a variety of practices, from using animations in presentations to providing real-world examples (Keller, 2012). To arouse interest, one approach is to tie a specific topic into a broader context. For example, to tie the topic of agronomic practices for the increase in biomass to food security and/or climate change mitigation. This wider context is often emergent in PBL, where learning is tied to real-world settings.

Relevance encompasses the connections between what and how is taught – or learned – and what are the student's aims, experiences, and/or learning styles (Keller, 2012). The student needs to feel that learning has a meaning, which is important in terms of, e.g., personal development, solving societal challenges, or landing a job. Using real-life problems in teaching, as in PBL, and organizing field or alumni visits can increase the sense of relevancy in students.

Confidence refers to student's perception of control and belief in their abilities to learn and achieve an assignment (Keller, 2012). Too difficult tasks or hard demands are likely to reduce confidence and, thus, motivation, but so are too easy tasks that do not provide a challenge.

Satisfaction, for example, through fairness, equity, rewards, and feeling pride is crucial for enjoying the learning process and, thus, arousing and maintaining motivation (Keller, 2012). Hence, remember to treat students equally, provide positive feedback, and even celebrate with students when they have succeeded.

MOTIVATING STUDENTS: DO'S AND DON'TS

Now you have a basic understanding of what enhances motivation. To help put this knowledge into practice, we have formulated seven dos and don'ts for PBL classrooms.

(1) Formulate an authentic, yet not too demanding or too easy problem scenario that relates to the topic and discipline. Generally, problem scenarios coming directly from the world of work, i.e., challenges faced by an existing institution, are more motivating than problems made up by the teacher. Working together with the labour market also provides students with the opportunity to showcase their competences to potential employers, enhancing motivation.

(2) Do not order students around, telling them what to do. This is just likely to make students feel intimidated and arouse resistance and frustration. Freedom and autonomy are the keys to motivation.

(3) Do not lecture and provide ready answers. Promote student activity and participation by challenging students with questions and enhancing doing – instead of just listening or reading. Allow students also to challenge you.

(4) Guide students throughout the learning process. Allow students to determine how to approach the problem and the possible ways to find solutions. If the students are going in the wrong direction, don't provide them direct answers or instructions, but guide them through questions and allow them to realise alternative ways.

(5) Be easily approachable and create a supportive learning environment, where students can believe in themselves and their peers. In case of challenges within the teams or among students, intervene and solve the issues immediately. A poor learning environment and conflicts will lead to a rapid decline in motivation.

(6) Tie theory to practice and convince students why learning something is important. Also help them to understand where and how they can utilise their learnings.

(7) Provide regular feedback to students and organise discussion sessions where you guide the students to discuss and reflect on what they have learned.

THE FINAL WORDS

The motivational approaches and examples provided in this article are not tied to PBL only. They can be used in any pedagogical approach. The main point of this article is, that PBL by an approach itself may not be enough to arouse and maintain students' motivation, but deliberate effort from the teacher is required. It is also important to understand that students are different and what motivates one may not motivate another. Thus, it is good to try and implement different motivating approaches. Motivation enhances students' learning, but it also brings secondary benefits to the teacher, as motivated students tend to motivate the teacher and make the teaching more enjoyable.

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Building effective student teams in problem-based learning

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ABSTRACT

Teamwork is essential in problem-based learning (PBL), in where students learn by solving authentic problems collaboratively in teams. Functional teams aid the learning process while dysfunctional teams can cause frustration and demotivation. Thus, teacher plays a core role in creating environment conducive to effective, fruitful and motivating teamwork. This article reviews factors affecting teamwork performance, and provides step-by-step approach to building, PBL student teams, team spirit and effective teamwork.

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INTRODUCTION

Teamwork is a core component of problem-based learning (PBL). In PBL learning happens through dealing with authentic problems in student teams. For solving the problem, students need to share information and construct and apply knowledge together (Fontejn & Dolmans, 2019). This process develops students' content knowledge and other competencies, such as collaboration and critical thinking skills. Problem-based and team-based learning are associated with improved learning outcomes compared with traditional teaching methods (Fontejn & Dolmans, 2019; Huitt et al., 2015). However, a dysfunctional team may lead to frustration and demotivation of students (Fontejn & Dolmans, 2019).

Effective teamwork and supportive team spirit do not evolve by themselves but require attention and effort. PBL tutor has an important role and responsibility to create a setting conducive to effective, fruitful and motivating teamwork. Especially important is the initial teaming phase. A well-implemented team building is a key to successful teamwork and learning. In this article, we review factors affecting teamwork performance. Focus is on the teaming phase and on practical aspects: how PBL tutor can contribute to building up team spirit and effective teamwork.

FACTORS AFFECTING TEAMWORK AND TEAM-BASED LEARNING

Numerous factors affect teamwork performance. We have divided these factors into three main categories and nine sub-categories borrowing from Fontejn & Dolmans (2019) and Hoegl & Gemuenden (2001) (Table 1).

Team characteristics compose of member characteristics, i.e., team resource pool, and within team interaction and management. A tutor can't change the characteristics of team

members but can take these into account when forming the teams and guiding the teamwork. Team characteristics are not a sum of individual characteristics. Highly skilled and motivated team members may boost the performance of others or conversely dominate and demotivate them (Fontejn & Dolmans, 2019). As learning happens through information sharing and negotiation, it's vital to enable smooth team communication and coordination (Fontejn & Dolmans, 2019): to make sure that every ones' views and knowledge are appreciated, all members bring the effort to the work and are aware of responsibilities and work progress.

Teamwork efficiency does not rely only on the team itself, but also on the given problem/task and the educational context. Clearly defined, relevant and interesting problems, a supportive learning environment, sufficient time and a professional tutor all foster teamwork and learning (Fontejn & Dolmans, 2019).

Adopting and implementing problem-based and team-based learning for the first time may cause struggles for both tutors and students. However, studies show that with increased experience, the process starts to run smoother (Fontejn & Dolmans, 2019).

Table 1. Factors enhancing and hindering team building and teamwork efficiency. Sources: Fontejn & Dolmans (2019), Huitt et al. (2015) and Hoegl & Gemuenden (2001)

1. Team characteristics <i>What is the team resource pool, and how is the team interaction and management?</i>	2. Problem/task characteristics <i>What are the problem and tasks characteristics?</i>	3. The learning context <i>What is the learning environment and culture?</i>
1.1 Team member characteristics <ul style="list-style-type: none"> • Personality <i>Some personal characteristics, such as extraversion, increase the likelihood of appreciating teamwork, as others, such as conscientiousness, decrease the likelihood.</i> • Abilities <i>Skillful students can enhance group performance, but also dominate and demotivate other group members.</i> • Experience <i>Previous experience on teamwork increase the likelihood for smooth process.</i> • Motivation <i>Motivated students can enhance learning of others through elaborating information sharing and peer-feedback. Social motivation, such as collaboration and fairness, increase group performance, while lack of it, mainly in the form of free-riding, decrease performance.</i> 	2.1 Problem formulation <ul style="list-style-type: none"> • Clarity <i>Clear and understandable problem and problem formulation arouse team discussions</i> • Appeal <i>Interesting, relevant problems increase motivation and are preferred by students.</i> 	3.1 Learning & teaching culture <i>Authoritarian, directed and competitive classroom culture may hinder team performance. Students not familiar with autonomous learning may have initial struggles to adapt to a new learning approach</i>
1.2 Team diversity and size <ul style="list-style-type: none"> • Heterogeneity <i>Group heterogeneity may lead to a larger resource pool and learning from each other, but on the other hand also sub-grouping and increased team tension.</i> • Amount of team members <i>Large groups may lead to coordination difficulties, while small groups have higher delivery cost.</i> 	2.2 Task execution <ul style="list-style-type: none"> • Interdependency <i>Interdependent and interconnected (sub)tasks enhance communication and knowledge sharing among students.</i> 	3.2 Tutor characteristics <i>The tutor's professional expertise in the given discipline and facilitation skills enhance the tutoring quality and teams' performance.</i>
1.3 Communication, interaction and team climate <ul style="list-style-type: none"> • Information and view exchange <i>Frequent and open communication with an appreciation of different views enhance team performance and learning.</i> • Psychological safety <i>Psychological safety increase motivation and improve information and viewpoint sharing. Lack of means to deal with conflicts and within group dominance may lead to polarization and overlooking of input and viewpoints.</i> • Team perception <i>Reaching and developing commonly agreed understanding on the problem interpretation and shared perception of team ability foster team confidence and subsequently performance.</i> 		3.3 Time allocation <i>Time pressure or lack of sufficient time decreases the quality of discussions and other activities and thus, learning.</i>
1.4 Coordination <ul style="list-style-type: none"> • work effort and expertise <i>Structured and synchronized team and individual effort improve team effectiveness. Equal participation and effort build team spirit and motivation. Recognizing each member's expertise and knowledge enables their utilization.</i> • work structure <i>Common understanding and agreement on the work structure, e.g., schedules and contributions, improve work efficiency</i> 		

SIX STEPS FOR TEAM BUILDING IN PBL

Ten years of experience in tutoring problem-based and team-based learning at Häme University of Applied Sciences (HAMK) in Finland, has led to the development of a concrete step-by-step approach to team building:

1. Forming the teams to determine the team resource pool. On a rule of thumb, five students are functional team size. With larger teams, there may not be enough work for all and smaller teams may cause a heavy workload on the tutor and the students. There are various methods for team formation. All these methods have their strengths and weaknesses and there is no one right method. The tutor may try different methods in different courses to see what works best. These methods are, for example:

- purposefully selecting students with given characteristics to create diverse and equally potent teams. Characteristics considered can be study level or program, gender, personality or other attributes. HAMK sometimes uses Belbin© team role tests to build teams of students with different personal characteristics.
- allowing students to form teams themselves to enhance students' motivation and reduce team tension. For example, students interested in the same topic or having a common goal towards the course can team up.
- randomly distributing students to the teams to avoid sub-grouping and too homogenous teams.

2. Getting to know the team members to understand the team resource pool, to boost team climate and enhance coordination. Students discuss their expertise and interests as well as objectives and motivation for the course. This enables

students to a) recognize the skills and expertise each member can bring to the teamwork, and b) estimate the effort each member will probably bring to the teamwork. The tutor should encourage students to be open and honest during these discussions.

3. Choosing the communication channel to boost communication and interaction. Each team chooses a communication channel and formulates rules for communication. Usually, the most functional communication channel is something the students use in their daily life. Official channels may prohibit informal communication and interaction. To avoid misunderstandings and conflicts, it's wise to establish communication rules: when messages can be sent, what happens if someone does not respond to messages, and at what time members should reply to messages.

4. Defining roles and responsibilities to boost team climate, the resource pool, coordination and interaction and to avoid free riding. Students define different roles for each team member. Depending on the group tasks, the roles can be for example team leader, secretary, within team communication manager, tutor-team communication manager and typewriter. The roles are permanent for the whole course yet is recommended that students change their roles in upcoming courses. When the actual work starts, students share responsibilities, i.e., work tasks, for each member. Students themselves should check regularly, e.g., weekly, that everyone is on top of their responsibilities.

5. Creating team rules to enhance team spirit, motivation, coordination and communication. Each team writes down team rules to be signed by each team member. The rules should contain at least the following: what is aimed at the means of grade and

learning, the work schedule, working methods, attendance requirements and what happens if the rules are not followed. The tutor may provide a draft template for team rules. To build up team spirit, the rules can be funny. For example, HAMK students have sometimes agreed that as a penalty for absence or missing a deadline, chocolate needs to be brought to other team members. At the latest at this point, the tutor should also explain the course rules to students, e.g., how the grade will be formulated.

6. Monitoring performance to enable using the team resource pool to the fullest, enhance learning and guide the team to the right track. The tutor monitors the team's work performance. There should be at least two monitoring discussions within a course: in the middle point and at the end. The tutor sits down with each team and discusses with its members how the work is going and has the communication, team rules and collaboration worked. If any issues arise, the tutor solves them together with the team. These sessions and the information obtained from them can be used as a part of determining the grades.

CONCLUSIONS

Working in teams is an effective way for students to develop 21st-century skills valued by employers. Yet, dysfunctional teams may cause demotivation and hamper learning. For enabling inspiring teamwork and comprehensive learning, it's important to focus on the first phase of teamwork, team building. Successful team building increases the likelihood of successful teamwork and learning. To build effective, motivated and supportive teams, the tutor needs to be aware of factors affecting teamwork quality and possess human and management skills. Tutor's, as well as students' teamwork skills, develop with practice. The step-by-step team-building approach presented in this article can

be used as a guide to bringing team-based learning to the classroom.

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Assessment and evaluation of students in problem-based learning

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ABSTRACT

The importance on developing students' soft skills and transferrable competences is widely recognised. Yet, the assessment and evaluation of these competences is challenging, particularly in differentiating individual performance from teamwork setting, focusing on what to assess, and summing the assessments into a final evaluation. Despite and because of these challenges, teachers should pay special attention to assessment and evaluation methods. Assessment and evaluation play a key role in competence development, as students tend to learn what they are assessed for. This article presents suitable, practical assessment and evaluation methods for PBL.

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INTRODUCTION

Educators around the globe and within different disciplines understand the importance of providing students with soft skills and transferrable competencies needed in the world of work. Moreover, they are generally eager to implement different pedagogical methods, such as problem-based learning (PBL) to deliver these competencies to students. One of the major challenges in implementing PBL relates to assessing and evaluating students and their competence development. We have noticed that many teachers, us included, find it initially difficult to transform from old habits of grading content knowledge with exams to assessing students' soft skills and wider set of competencies. The main challenges of assessment and evaluation of students in PBL relate to differentiating individual performance and contribution in the teamwork setting, narrowing and focusing the list of what to assess, and summing the assessments into a final evaluation (Albanese & Hinman, 2019).

In this article, we present suitable assessment and evaluation methods for PBL. We cannot emphasise the importance of assessment enough. As students tend to learn what they are assessed and graded for, the assessment plays a key role in competence development. We acknowledge that it is also important to assess and evaluate the curriculum, PBL course, and the facilitators, as there is always room for improvement (Albanese & Hinman, 2019). However, this article focuses solely on the assessment and evaluation of students.

ASSESSMENT VS. EVALUATION

According to Albanese & Hinman (2019) assessment can be divided into two domains: formative assessment (referred to hereafter as "assessment") and summative assessment (referred to hereafter as "evaluation").

Assessment happens throughout the course or semester through various instruments. It aims to inform about the learning process and can be considered a tool **for** learning (Albanese & Hinman, 2019). Students gain an understanding of their learning progress and identify areas of improvement (Albanese & Hinman, 2019). Regular feedback based on the assessments guides students to improve their achievements and has been found to increase motivation towards learning (Albanese & Hinman, 2019).

Evaluation, in turn, takes place at the end of the course or semester. It focuses on the student's learning progress and achievements, i.e. assessment **of** learning to provide the final grade (Albanese & Hinman, 2019).

ASSESSMENT THROUGHOUT THE COURSE

The object of assessment in PBL can be roughly divided into two: the learning (or teamwork) process and the learning (or teamwork) products (Albanese & Hinman, 2019). The process assessment focuses on factors such as contribution to the work, learner's activity, communication and interaction within the team and the class, following deadlines, and so on, i.e. under scrutiny is the process of learning. The assessment of learning products, in turn, scrutinises the physical learning outcomes, such as essays, reports, learning diaries, presentations, tests, and exams, and in modern educational approaches, such as project/problem-based learning, various drafts and prototypes made by students. (Albanese & Hinman, 2019). In a teamwork setting it may be challenging to identify different team members' contributions to the final product.

The biggest challenge in PBL is probably not what to assess but rather **how** to assess.

Thus, we composed a “starting” package for teachers on assessment methods and tools (Table 1). We want to emphasise that this is not a complete list of assessment methods but just a glimpse of the possibilities, only your imagination sets the limits.

It is recommended to use various, and at least more than one, assessment methods in a given course.

Table 1. Examples of various assessment methods that can be used in problem-based learning. Sources: Albanese & Hinman (2019) and authors’ own experiences.

Method	Description	Benefits (+) and shortcomings (-)
Peer-review/Peer-assessment	Students can assess/grade other students’ learning products, such as essays, if provided with sufficient guidelines and tools for this. Peer students can assess and provide feedback on other students’ learning processes, such as contributions to teamwork and cooperation.	<ul style="list-style-type: none"> + Assessing other students’ work acts as a learning process for the assessor. + Peer-assessment is more likely to provide accurate information compared to self-assessment. – Not all students are capable of providing constructive feedback or assessment. – Multiple (student) assessors lead to multiple views and do not offer a uniform or equitable assessment of all students.
Self-assessment	Students self-assess their learning outcomes and the learning process, utilising the tools provided by the teacher. Self-assessment can be narrative (open-ended questions to the students), quantitative (closed-ended questions for students), or a combination of both.	<ul style="list-style-type: none"> + Self-assessment helps students to identify their knowledge and skills gaps and may motivate them to close these gaps. + Self-assessment promotes self-directed learning and self-reflection skills. – Self-assessment may not provide accurate information. Talented students tend to underestimate their performance, while “weaker” students tend to overestimate theirs. To mitigate this effect, the teacher should provide guidelines for self-assessment, and self-assessment can also be practised.
Peer/team feedback	Student team members provide feedback on their fellow team members, especially their contributions to the team learning product. The feedback provision can be quantitative or qualitative and can be openly shared through, e.g. facilitated team discussions or only shared with the teacher through, e.g., a questionnaire.	<ul style="list-style-type: none"> + Peer feedback helps the teacher to identify individual contributions in teamwork and provide individualised grades. + Peer feedback may pressure students to contribute to the team processes. – Peer feedback may cause conflicts within the team.
Facilitator-assessment	The teacher and/or other course facilitator assess students’ learning products and/or the learning process. Pre-developed standard form for assessment eases the task and helps to uniform the assessment and focus on assessing the achievement of the pre-determined learning outcomes.	<ul style="list-style-type: none"> + Teacher can, based on the learning objectives, equitably assess all the students. – Teacher may not be in the best position to identify and assess individual performances and contributions within the student teams.
Tests, quizzes, and exams	Can be based either on open-ended, even essay types of questions or, e.g. multiple-choice questions. With default rights, answers can be uniformly and equally graded.	<ul style="list-style-type: none"> + Time and resource-efficient method for assessment of content knowledge. + If combined with a feedback system, it will provide students with an understanding of their learning progress and learning gaps. – Not a feasible method for assessing soft skills.

FINAL EVALUATION

The evaluation measures student performance and the achievement of the learning outcomes: it can be either a grade or just a pass or fail. The final evaluation has real consequences for students, i.e., the need to redo the course, the impact on the final graduation marks, the effect on the possibility to enrol in other courses or post-graduate studies, and so on. Thus, it's crucial to pay attention to the reliability and validity of the evaluation (Albanese & Hinman, 2019).

In PBL, it's recommended to compose the evaluation out of various components, including the previous assessments.

What needs to be considered in this type of evaluation is the weighting of the different assessments and their objectives (Albanese & Hinman, 2019). It may not be purposeful, e.g. to provide early-course assessments with the same weight as late-course assessments, as this does not give enough emphasis to the competence development.

Rubric (Table 2) is a practical framework that can be used in evaluation. It usually contains evaluation criteria, scores and their description, and weight for the learning assignments or components. Using rubrics can reduce the time used for grading and it's a good tool for providing feedback and justifying the grade to a given student.

Table 2. An example of a rubric framework for a reflective journal.

Criteria	Excellent (4)	Good (3)	Satisfactory (2)	Needs improvement (1)	Score:
Depth of reflection	Demonstrates profound insight, analysing experiences in detail and exploring personal growth deeply. Shows evidence of critical thinking and self-awareness.	Reflection is thoughtful, with a clear analysis of experiences and some evidence of personal growth.	Reflection is somewhat superficial but includes some analysis of experiences.	Reflection is basic and lacks depth; mainly summarises events without much personal insight.	
Connection to course material	Strong, clear, and relevant connection to course material, theories, or concepts. Integrates readings or lessons thoughtfully.	Adequate connection to course material, with some integration of concepts or theories.	Limited connection to course material; brief mention of theories or concepts with minimal application.	No meaningful connection to course material or theories.	
Clarity and organization	Writing is clear, well-organized, and easy to follow. Ideas are logically structured, with smooth transitions.	Writing is generally clear, with some organisational issues. Ideas are mostly easy to follow.	Writing is somewhat unclear or disorganised, making it difficult to follow some points.	Writing is unclear, disorganised, and difficult to follow.	
Personal growth & development	Demonstrates significant personal growth and insight. Reflects on how experiences have changed or influenced personal values, attitudes, or beliefs.	Demonstrates some personal growth and insight, but not fully explored. Mentions how experiences may have influenced values or attitudes.	Limited personal growth is discussed; does not provide enough reflection on how experiences have impacted personal development.	Little or no personal growth or development discussed.	
Critical thinking & analysis	Demonstrates excellent critical thinking by evaluating and questioning experiences, considering multiple perspectives.	Demonstrates good critical thinking, though may not fully evaluate experiences or perspectives.	Some critical thinking present, but analysis lacks depth or is limited to basic observations.	Lacks critical thinking, with little to no analysis or questioning of experiences.	

IT ALL STARTS WITH CURRICULA AND COMES DOWN TO CURRICULA

There are various tools and methods to utilise in assessing students on PBL, and by trial and error, one can find the most suitable for oneself or for a given course. However, it's vital to acknowledge that the whole assessment and evaluation process starts from the curriculum, which defines the specific learning outcomes. If the curriculum includes only skills and assessments related to content knowledge, the teacher has no incentive to implement PBL in the first place or to shift the assessment to include soft skills. The curriculum also directly impacts students' behaviour. If the grading of courses and/or final graduation marks are based only on memorising content knowledge, don't expect students to put effort into developing soft skills.

Thus, the proper assessment and evaluation can't be left the sole responsibility of the teachers, but the management staff play a crucial role in curricula development and providing teachers with the needed flexibility to adjust the assessment and evaluation methods for specific courses.

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Facilitating mentoring in problem-based learning: Experiences from a multi-mentor model

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ABSTRACT

The benefits and learning outcomes of problem-based learning (PBL) do not emerge by their own but require facilitation from the teacher. Effective and active facilitation is a core element of PBL. To enable this, also the teachers need to be facilitated and supported by the administration and peers. This article shares experiences of being a PBL mentor and provides concrete tips on how to facilitate PBL mentoring in multicultural and multi-mentor settings to ensure sustainable learning outcomes.

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INTRODUCTION

Problem-based learning (PBL) is a recommended method to deliver 21st-century skills and transformative competencies needed in the world of work. Reaching the full benefits of PBL requires active facilitation by the teacher — or a mentor, as teachers are often called in PBL. As PBL mentors, we know from experience that this is often easier said than done.

In this article, we share our experiences as PBL mentors. We briefly introduce PBL and the role of mentors in it and provide concrete suggestions on how to facilitate active mentoring in multicultural and multi-mentor settings.

MENTORS' ROLE AS A FACILITATOR

PBL is a student-centred, active learning method, used in various disciplines. In PBL, students learn in teams by solving ill-defined, real-life, and open-ended problems. Problem-solving and learning happen through five interlinked steps: (1) analysing the problem, (2) setting the goals, (3) collecting resources, (4) summarising ideas, and (5) reflecting on the experience (Lin et al., 2010; Figure 1).

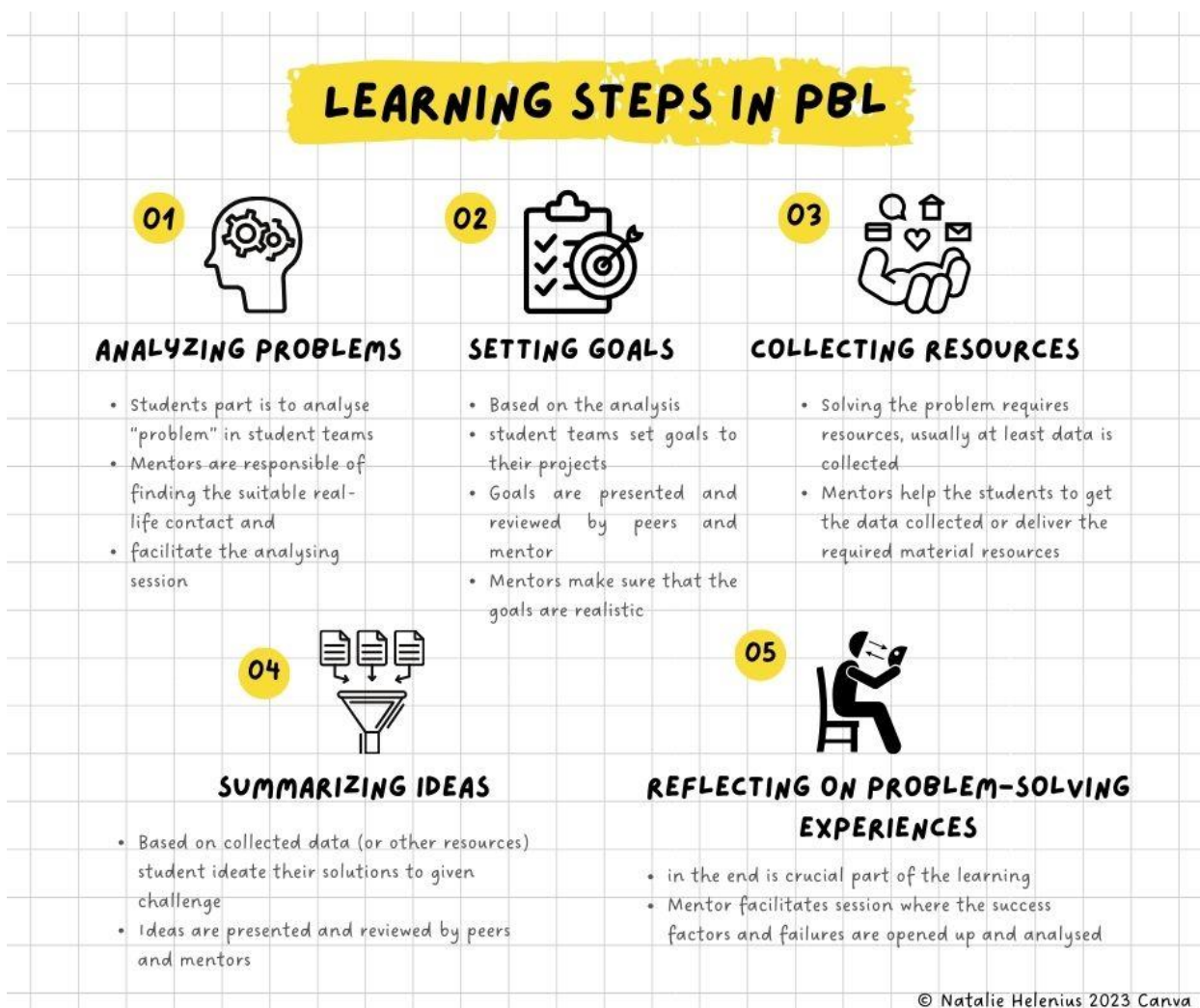


Figure 1. The five learning steps in PBL: analysing problems, setting goals, collecting resources, summarizing ideas and reflecting on problem-solving experiences (Lin et al., 2010).

PBL is becoming increasingly popular, not least because of the learning benefits associated with it (Yew & Goh, 2016). PBL enhances students' understanding of the core ideas and principles of their discipline and, through its practicality, supports students' perceptions of themselves as professionals (Hmelo-Silver et al., 2019; Lu et al., 2014). In addition, PBL supports the development of various 21st century skills such as analytical and critical thinking, collaboration, communication, self-direction, leadership and application of information. (Ding et al., 2014; Liu & Pásztor, 2022; Lu et al., 2014; Tan et al., 2014).

The PBL process and subsequent learning outcomes do not operationalise and emerge on their own but require facilitation. Effective and active facilitation by the mentor is essential in PBL (Hmelo-Silver et al., 2019; Liu & Pásztor, 2022).

Yet, for the mentor to facilitate learning, also the mentoring needs to be facilitated. Mentoring need support from the administration as well as from other mentors and peers. Especially in multicultural and multi-mentor settings — with several mentors from different cultures guiding student teams — facilitation of mentoring is crucial to ensure a smooth process and synergistic benefits.

FACILITATING MENTORING

As part of the AgriSCALE project (www.agriscale.net), and during the period from spring 2022 to spring 2023, we have participated as mentors in five multicultural student challenges. A student challenge is a learning concept — using the PBL approach — in which students from different universities and different countries come together to learn by working with real cases, i.e. scenarios or problems that the students aim to solve (Määtänen et al., 2022b). The cases are implemented in small, multi-cultural and

multi-disciplinary student teams. The students' work is carried out in 'real life', often including a fieldwork period of about two weeks.

Within student challenges, each participating university provides at least one mentor. The mentors are jointly responsible for mentoring all student teams, which means that all mentors interact with and guide all student teams.

During and through the student challenges, we have learnt that reaching proper facilitation does not come without effort, but that the mentors also need support and facilitation to be able to subsequently facilitate the students and their learning. We call this the facilitation of mentoring.

In the student challenges, the students come from different countries, cultures, universities, educational backgrounds and levels, and so do the mentors. Therefore, it is important that mentors get to know each other at the beginning of a student challenge. We strongly recommend that mentors not only introduce themselves and their background, but also openly discuss and share their thoughts about the process (Figure 2). Topics and issues to be discussed among mentors at the beginning of the PBL process include division of roles and responsibilities, strengths and weaknesses, hopes and fears, as well as the mentor's cultural background and background as a mentor.

At the beginning of the joint mentoring process, sufficient time should be devoted to building an efficient mentor team. This can be done by using the same methods as for forming student teams (Määtänen et al., 2022a). The difference between students and mentors in introducing and forming teams is that mentors should take care of this action themselves, whereas students need guidance and support from mentors.

The roles, responsibilities and tasks of the mentors should be agreed upon before the PBL process and should be discussed and modified frequently during the process. In multicultural and multi-university student challenges, there is usually a so-called 'host university', which is responsible for the organisation and practical aspects. The host university appoints a coordinator who communicates all relevant information to the participating mentors. This person may also be one of the challenge mentors.

We also recommend that one of the mentors should be in charge of the whole PBL process: making sure that all steps are considered and planned before the course starts. Another mentor could supervise the learning methods, tools and tasks and explain them to the students. All mentors should take responsibility for creating a safe and motivating learning environment. The workload of the participating mentors should be equally shared.

THINGS TO DISCUSS WITHIN MENTORS IN THE BEGINNING OF THE PROJECT



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Figure 2. Topics to discuss among the mentors at the beginning of the mentoring process.

Due to the multiculturalism of the student challenge and among the mentors, there is a high probability of an unclear hierarchy among the mentors, which can hinder cooperation and information sharing, and thus the progress and success of the whole student challenge. Cultural norms regarding, for example, the negotiating power of different genders, age groups or professional titles can vary widely. To avoid misunderstandings and related offence and conflict, and to enhance cooperation, it is recommended that mentors agree on basic house rules at the very beginning of the student challenge process. The rules can include aspects such as how decisions are made, and conflicts are resolved among the mentors and how they communicate with other stakeholders.

COMMUNICATION IS THE KEY

Despite extensive planning and follow-up, something unexpected is likely to happen during the PBL process. Participants may fall ill, external events may create challenges, or students may need more support than expected, to name a few. To face and overcome these challenges, mentors should have regular discussions. These discussions do not have to be long and extensive, but mentors can, for example, organise a short 15–30-minute catch-up meeting each day, where each mentor shares his/her feelings and concerns. This is likely to increase tolerance and adaptability to changing situations. Longer and more in-depth mentor meetings focusing on overall project issues, timetables and regular evaluation of student progress and mentoring effectiveness can be arranged less frequently, e.g., every other week or once a month, depending of course on the length of the student challenge.

The importance of communication between mentors should not be underestimated. Mentors are often busy, they may feel they

have more important things to do, and it can be difficult to find a time that works for everyone. However, a lack of communication often not only causes stress, but also slows down the PBL process and ultimately leads to an increase in the amount of time needed to complete the process. From the students' point of view, stressed and out-of-date mentors are not able to provide the support and may even be detrimental to the students' learning process.

Well facilitated and implemented mentoring will take effort, especially in the early stages, but we can guarantee that it will be worth it. Successful mentoring is rewarding and creates a sense of achievement not only for the mentors but also for the students.

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Large classes pose a challenge for problem-based learning: Truth or myth?

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ABSTRACT

The benefits of problem-based learning (PBL) are widely acknowledged, and the teaching method is used around the globe. Despite the interest and will to implement PBL, many educators perceive being constrained by large class sizes and sufficient resources. To overcome these challenges, this article presents practical solutions on implementing PBL with large classes and with reasonable effort. Practice makes perfect and through accumulating experience educators around the globe and plan and implement PBL in diverse learning environments.

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INTRODUCTION

Problem-based learning (PBL) is a recommended educational approach to develop 21st-century skills and transformative competences needed in the world of work. PBL promotes active and authentic learning, with learning driven by real-life problem-solving within student teams.

Häme University of Applied Sciences (HAMK) is promoting and championing PBL in sub-Saharan educational institutions through its Africa projects. PBL has aroused huge interest among the African partner institutions. The university staff, both teachers and administrators, have been eager and thrilled to implement PBL. They have developed their own PBL plans for courses (see e.g. Kavwanga et al., 2022; Mulonda et al., 2022), and noticed PBL's benefits (Hamukwala et al., 2022; Ojok et al., 2022). Some of the project participants, students, and staff alike, have even promoted PBL to other universities within Africa.

However, many of the educators perceive large class sizes and lack of sufficient resources to hinder the adoption and implementation of PBL in their home universities, and universities across Africa. Yet, this does not need to be the case. PBL can be used in many different settings, both with large classes and with minute resources (Amoako-Sakyi & Amonoo-Kuofi, 2015). In this article, based on the main author's extensive experience as an educator, we provide practical solutions on how to implement PBL with large classes with reasonable effort.

PBL WITH LARGE CLASSES

PBL is often conducted within rather small student teams, consisting of 5–7 members, and with a tutor guiding the teamwork. It is advisable to increase the number of student teams, rather than to increase the student members within a team.

One tutor can handle more than one student team. To ease the tutor's work, without compromising the learning, different student teams can do partly combined tasks. For example, student teams can be "brought together" through panel discussions, debates, or a common task, where student teams focus on different dimensions of one topic. The mentor can then monitor and guide the work of all the student teams. With this method, one mentor can supervise quite a large number of students.

However, for the first time using PBL, large class sizes can be a challenge. In these cases, either the number of tutors should be increased, or alternatively one can start reaching PBL step by step by utilizing active learning methods. Active learning refers to various student activities or tasks in which students actively construct and reflect their knowledge and understanding (Brame, 2016). An example of an active learning task is organizing 10-minute group discussions in mini student teams comprising 3–4 members or arranging learning games for students (e.g. Whenham, 2020). After both the teacher and the students have become familiar with active learning strategies and methods, it will become easier to implement pure PBL – even within large classes.

Rubric assessment tools, as well as peer assessment, i.e., students assessing each other, are useful in evaluating and grading large student numbers (Rhodes, 2010). This should not take more time than reading and assessing multiple essays or exams.

PRACTICE MAKES PERFECT

A common misconception is that PBL would require a number of physical and monetary resources, such as equipment and field work periods. However, in most cases, PBL can be implemented within classrooms or in online environments with rather minute resources.

The main resources needed in PBL are the tutors and their time.

Planning and implementing PBL, especially for the first time, may, and usually will, take more time than just preparing for and holding lectures. Yet, with more experience and established habits, planning and implementing PBL requires less and less time and effort.

Careful preparation goes a long way in implementing PBL. Familiarising with different PBL implementation methods and examples, through for example literature, will save time later, in the actual implementation, as well as in subsequent PBL courses.

It is advisable to reflect on each PBL course – or each PBL task if a hybrid model combining traditional teaching and PBL is used – and update plans for the next course or task accordingly. One can, for example, collect feedback from students, and ponder what went well and what did not, and how things could be done differently next time. Done time and time again, this will reduce the effort needed for PBL implementation.

The saying “*practice makes perfect*” applies not only to PBL tutors but to students alike. When students face PBL methodology for the first time, they may find it challenging (Abbey et al., 2017; McCowan, 2018), and thus, require a lot of guidance and support from the tutors. However, as students get familiar with the learning method, the more they start to take responsibility for their learning and on the learning task, and the tutors’ workload will subsequently reduce.

UP-SCALING PROBLEM-BASED LEARNING

PBL has been proven an efficient method to develop students’ 21st-century skills, and the method has gained more and more popularity around the world. Breaking the assumptions

of PBL requiring vast resources can make the practice even more common, especially in countries that struggle with limited educational resources. We hope that this article will encourage and help educators around the world to plan and implement PBL within various of different settings.

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