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**A Guide to Facilitate Development of
Progression of PBL Competences**
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A GUIDE TO FACILITATE DEVELOPMENT OF PROGRESSION OF PBL COMPETENCES



United Nations
Educational, Scientific and
Cultural Organization



AALBORG UNIVERSITY

Aalborg Centre for Problem Based Learning
in Engineering Science and Sustainability
under the auspices of UNESCO

Jette Egelund Holgaard
Anette Kolmos
2021

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PREFACE

This material has been prepared by the Aalborg Centre for Problem Based Learning in Engineering Science and Sustainability under the auspices of UNESCO (The Aalborg PBL Centre) in order to support the work on progressive intended learning outcomes for PBL competences (PILO) in the curriculum. The material was targeted study programmes at the Technical Faculty of IT and Design (TECH) and the Faculty of Engineering and Science (ENG) at Aalborg University (AAU). The work on preparing the material lasted from November 2018 to January 2019. In 2020, the material was translated to English for broader use.

The material is prepared as part of a project following the AAU strategy “Knowledge for the World”, where all degree programmes at AAU were to include PILOs for PBL in their study programmes. There is no doubt that students at AAU encounter a progression in their PBL competences during their time as students, as they gain greater experience with different types of problems, groups, supervisors, etc. However, the purpose of the work on PILOs for PBL is to create clarity, clearer direction and greater awareness of what PBL competences students have to achieve through their studies.

In the preparation phase, meetings were held with both vice deans for education at The Technical Faculty of IT and Design (TECH) and The Faculty of Engineering and Science (SES). These meetings provided direction and valuable input on how to facilitate staff to co-construct PILOs for PBL. The Aalborg Centre for PBL would therefore like to thank Jakob Stoustrup and Olav Geil for their engagement and support in this process.

The Aalborg Centre for PBL would also like to thank Head of Studies Søsler Brodersen at the Department of Planning, as well as the teachers at the Sustainable Design education for their willingness, commitment and input at a pilot workshop that was held to test the developed material. Further thanks is extended to this group for making us share pictures from the workshop to visualise the use of the material presented in this guide.

The Aalborg Centre for PBL wishes you a creative and enlightening process of developing PILOs for PBL, and we hope that the material can fully or partially inspire similar processes in other

Aalborg, March 2021

On behalf of The Aalborg PBL Centre
Jette Egelund Holgaard and Anette Kolmos





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INTRODUCTION

This guide has been prepared to facilitate the process of developing progressive learning outcomes (PILOs) for PBL competences in engineering and science studies at Aalborg University (AAU). It should be emphasised that the material is intended as *guidance only* and for *inspiration*, as the local educational context has to be taken into consideration.

The starting point is the following four competence areas:

- *problem-oriented competences*, including the ability to identify, analyse, formulate and address authentic problems in an exemplary manner.
- *interpersonal competences*, which includes the ability to communicate and collaborate in a team and with external partners to address complex problems.
- *structural competences*, including the ability to manage problem based processes e.g. in a project organisation.
- *meta-cognitive competences*, which includes the ability to develop PBL competence as well as to transfer learnings from one PBL environment to another.

Based on these four PBL competence areas, progression is viewed in between two transitions points of moving into the study (from pupil to student) and out of the study when graduating (from student to professional). There can be different ways of supporting the progression of PBL competences in between these two transi-

tion points. At engineering and science studies at AAU the students are supported by research based courses and workshops on PBL throughout their study including a workshop on PBL competence profiling. In this guide the focus is however how to facilitate staff in developing PILOs to be integrated in the curricula, while taking into concern students' educational profile when entering the study and the alignment of the PBL competence profile at graduation with societal needs to ensure employability.

The guide and related material has been prepared by The Aalborg Centre for Problem Based Learning in Engineering Science and Sustainability under the auspices of UNESCO, and therefore the material is appropriated to an engineering and science context. However, the material is also made available for potential adjustment to disciplinary differences as well as to other educational contexts at <https://www.ucpbl.net/>.

In the following, a stage model is proposed to support staff in developing PILOs for PBL competences at programme level followed by a short introduction to material used to support the process in the different stages of the process. All material has been qualified in the AAU case by meetings with vice deans for education as well as heads of study. Furthermore, the material was tested at a pilot workshop including participation from the head of study, programme responsible and PBL teachers from the Sustainable Design programme.



PROPOSED STAGES OF CREATING PILOS FOR PBL

In the following, proposals are put forward for five stages in the formulation of PILOs for PBL:

1. Idea generation
2. Reflection and outreach
3. Prioritisation and framing
4. Concretisation
5. Realisation

Idea generation is the starting point to stress the importance of moving beyond what we already do or what we at first hand would formulate as PILOs for PBL. The intention is to make sure that different perspectives on PBL is considered, challenged and specified in the context of the specific programme. Furthermore, it is a basic premise that the process is as inclusive as possible to provide experience based input and local ownership of the ambition to systematically support progression of students' PBL competences.

Stage 1 – Idea generation

It is recommended that programme directors arrange a workshop which includes key staff from the programme and if possible student representatives. At AAU, it was recommended to have a three-hour workshop with the head of programme, the study board and semester co-ordinators. In this way, students would also be represented through their representation on the study board. Depending on the diversity of the programmes, workshops can be arranged for each programme or across programmes.



The following is a suggestion for an agenda, to be adjusted for own purposes:

9:00–9:10 Welcome, brief information to the background and agenda

9:10–9:20 Overall view on progression and PBL competence areas

9:20–9:30 Presentation of materials for workshop – thematic dialogue cards, post-it categories and overview sheets

NOTE! Cf. the following section presenting the tangible materials to support the process. As a supplement, it would be an advantage if one member brings a computer to allow participants for further search to explore and elaboration on themes.

9:30–10:15 Group work – idea generation

NOTE! Groups of 2–4 people are formed. There must be at least four groups (which must cover the four competence areas). If there are fewer than eight participants, two groups can be formed and the session divided into two, where 30 minutes are allocated per group per theme. This shortens the recap by half an hour due to the reduced number of groups. If you want 45 minutes for each theme, you can also start half an hour earlier. For more than four groups, the themes are distributed so that the themes that is most challenging are handled by a correspondingly greater number of groups. The use of the dialogue cards are presented in the following section.

10:15–10:30 BREAK

10:30–10:45 Getting ideas into structure

NOTE! The ideas are structured according to semesters as elaborated in the following section.

10:45–11:05 Progression check

NOTE! When all ideas are related to the semesters, the progression is evaluated and additional posters potentially added.

11:05–11:45 Presentations by the groups

NOTE! If there are multiple groups per theme, one is asked to comment and one is asked to supplement – i.e. 10 minutes per theme.

11:45–12:00 Rounding off and next step

Stage 2 – reflection and outreach

Document the work (at least take a picture of the overview sheets).

Place the overview sheets in a central meeting place (lunch room or similar) for the next two to three weeks – make sure to inform people about the work and ask for further inputs. Assign a contact person to ask for further information if needed. Make sure that “fresh” post-its have clear reference (e.g. initials), so that additional elaborations or questions to the input is possible.

Stage 3 – prioritisation and framing

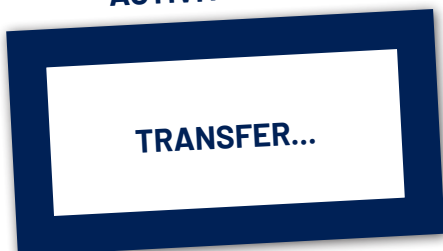
It is recommended that the study board collects and prioritises the collected ideas from stage 1 and 2, so as to allow a clear process for the further work on formulating the PILOs for PBL as well as associated teaching and evaluation activities.

It is recommended that the priorities from the study board are shared with representatives from key employers and superior educational managers to get additional feed-back as well as Stage-Gate approval.

QUALIFICATION CARD



ACTIVITY CARD



EVALUATION CARD



Stage 4 – concretisation

When PILOs for PBL are to be formulated and aligned with corresponding teaching and evaluation activities, it is recommended to call for a follow-up workshop. Yet again, a three-hour workshop is recommended, and a suggested agenda is as follows:

9:00–9:15 Welcome, introduction to the agenda and the idea of constructive alignment

9:15–9:30 Presentation of the starting point (outcome of stage 3) and new sets of dialogue cards: qualification cards, activity cards, evaluation cards.

NOTE! Cf. the elaboration in the following section. As a supplement to the dialogue cards, it would be an advantage if one member of the group brings a computer to write in the proposed PILOs for PBL in the context of the curricula.

9:30–10:30 Group work – ideas for PILOs for PBL based on the dialogue cards

NOTE! Groups of 2–3 people are formed. A number of prioritised themes/ideas are distributed to the individual groups. For each idea and based on a three step process of using the qualification, activity and evaluation cards in a step-wise manner, the aim is to formulate specific PILOS and, in this context, supportive teaching and evaluation activities.

10:30–10:45 BREAK

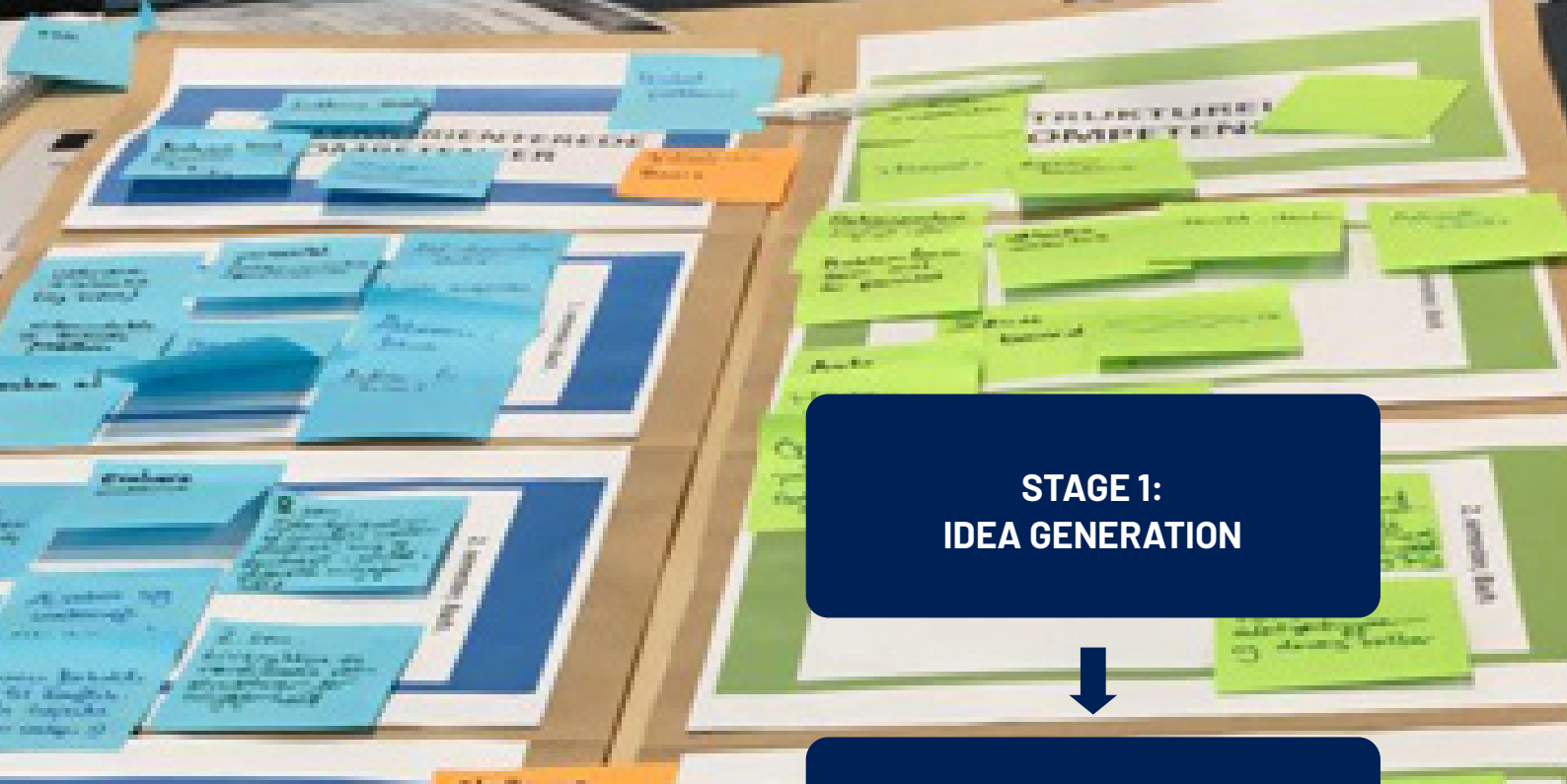
10:45–11:00 Progression check

NOTE! The formulated PILOs for PBL are listed in a semester order, and it is checked whether the qualification cards used indicates an appropriate order of progression.

11:00–11:45 Presentations by the groups

NOTE! REMEMBER time for discussion!!

11:45–12:00 Recap and next step



**STAGE 1:
IDEA GENERATION**



**STAGE 2:
REFLECTION AND OUTREACH**



**STAGE 3:
PRIORITISATION AND FRAMING**



**STAGE 4:
CONCRETISATION**



**STAGE 5:
REALISATION**

Stage 5 – realisation

Based on input from the workshop held in stage 4, the study board completes and incorporates PILOs for PBL in the curriculum.

In this way, the process has moved from the idea-generation stage to the integration of explicit PILOs for PBL as illustrated by the flow diagram.

Learning goals (e.g. from Bach. Energy)

Being able to identify own learning needs and structure own learning in different learning environments.



TOOLS FOR THE STAGES OF THE PROJECT

In the following, the tools prepared for the above workshops will be reviewed. Again, note that the work is based on the presentation of the before mentioned PBL competence areas, as well as AAU PBL principles, which can be found here.

The following material will be introduced in this section:

- Dialogue cards of different kinds
- Suggestions for use of post-its and sheets to organise ideas

ABOUT THE DIALOGUE CARDS

The purpose of dialogue cards is to provide a starting point for dialogue and, in this process, idea generation. Thus, dialogue cards have not been developed in order to create a complete overview of a field – in fact, they may be just as important to spot what is missing. Dialogue cards are thereby only for inspiration and to kick-start the process of idea generation.

For the workshop, 48 thematic cards have been developed for the idea generation stage (divid-

ed into four categories of 12 cards), as well as 12 qualification, 12 activity and 12 evaluation cards for the concretisation stage. The four categories of the thematic cards correspond to the problem-oriented, the interpersonal, the structural and the meta-cognitive competences.

The purpose of the dialogue cards is to inspire the dialogue about PILOs for PBL in groups of 2–4 persons. It has been decided in advance that 12 dialogue cards are prepared for each category, as this makes it possible to distribute dialogue cards evenly among the groups, and at the same time it provides a feasible total number of dialogue cards for the group.

It is recommended to work f-2-f and with physical cards. A PowerPoint presentation has been prepared with the 12 pre-made cards which, when printed with four slides per page, results in a suitable size for the dialogue cards (find material at UCPBL.net). It is recommended that the cards are laminated, printed on as thick paper as possible, or alternatively, attached to a backing of cardboard.

The following is a list of the six categories for the dialogue cards.

THEMATIC CARDS - PROBLEM ORIENTATION

The thematic cards on problem orientation contain some keywords that relate to the relationship between the student and the problem. There is a focus on creating an understanding of, and working with, authentic problems, and on solutions having an authentic effect as well.

1. Problem types
2. Problem identification
3. Problem analysis
4. Creativity
5. User involvement
6. Cultural context
7. Sustainability
8. Ethics
9. Problem definition
10. Problem solving
11. Technology assessment
12. Impact scenarios

THEMATIC CARDS - INTERPERSONAL COMPETENCES

The thematic cards on interpersonal competences contain some keywords that relate to the mutual relationship between the students and their partners in a problem-based learning environment.

1. Team building
2. Team culture
3. Team roles
4. Communication strategies
5. Conflict management
6. Active listening
7. Constructive feedback
8. Decision-making processes
9. Academic and problem based communication
10. Group collaboration
11. Co-operation with external parties
12. Professional ethics

THEMATIC CARDS - STRUCTURAL COMPETENCES

The thematic cards on structural competences contain some keywords that relate to the relationship between the student and the structures in problem-oriented work. As a project organisation is a common of structuring problem-oriented work, the cards represent this discourse.

1. Project types
2. Project management strategies
3. Distributed project management
4. Delegation
5. Objectives
6. Time management
7. Agile management systems
8. Meeting types
9. Meeting management
10. Collaboration agreement
11. (Planning of) external collaboration
12. Study technique

THEMATIC CARDS - META-COGNITIVE COMPETENCES

The theme cards on meta-cognitive competences contain keywords that relate to the relationship between the student's practice within the problem-oriented work and the more general and underlying view that enables the student to develop his or her own practice in a qualified manner.

1. Personal development goals
2. Alignment with curricula objectives
3. PBL competence profile
4. Employability
5. Career planning
6. Learning style
7. Resilience
8. Motivation
9. Process analysis
10. Learning theory
11. Responsibility for own learning
12. PBL principles <-> practice

QUALIFICATION CARDS

Qualification cards are structured around verbs, which are typically used within a problem-based learning environment to express expected qualifications. The 12 verbs thus relate to what a student is expected to be able to do.

1. Plan...
2. Exemplify, based on your own experiences...
3. Relate to...
4. Apply "x" theory to...
5. Apply "y" method to...
6. Experiment with ...
7. Analyse...
8. Reflect on...
9. Evaluate...
10. Optimise...
11. Discuss...
12. Transfer...

ACTIVITY CARDS

Activity cards are structured around types of teaching activities that can support problem-based project work.

1. Supervision of project work
2. Facilitation of case work
3. Online classes
4. Inspirational lectures
5. Thematic workshops
6. Presentation seminars
7. Exercises combined with targeted feedback
8. Excursions
9. Facilitation of cross-group collaborations
10. Facilitation of interdisciplinary co-operation
11. Facilitation of external co-operation
12. Ad-hoc individual coaching sessions

EVALUATION CARDS

Evaluation cards are structured around different aspects of evaluating PBL competences.

1. Written exam based on reflection documents
2. Written exam based on case work
3. Oral exam based on reflection documents
4. Oral exam based on case work
5. Passing through active participation
6. Integration in project exam
7. Individual examination
8. Formative evaluation in the group
9. Formative evaluation across groups
10. Formative evaluation across semesters
11. Formative evaluation across programmes
12. Self-evaluation

SUGGESTED USE OF POST-ITS AND SHEETS FOR STRUCTURING

At the idea-generation stage, post-its and a sheet to organise the post-its in relation to the semesters are used to get an overview of the progression considering the variation and recurrence of themes. The colour codes of the thematic cards are linked to post-its of the same colour, by using the following codes:

Blue: Problem-oriented competences

Pink: Interpersonal competences

Green: Structural competences

Yellow: Meta-cognitive competences

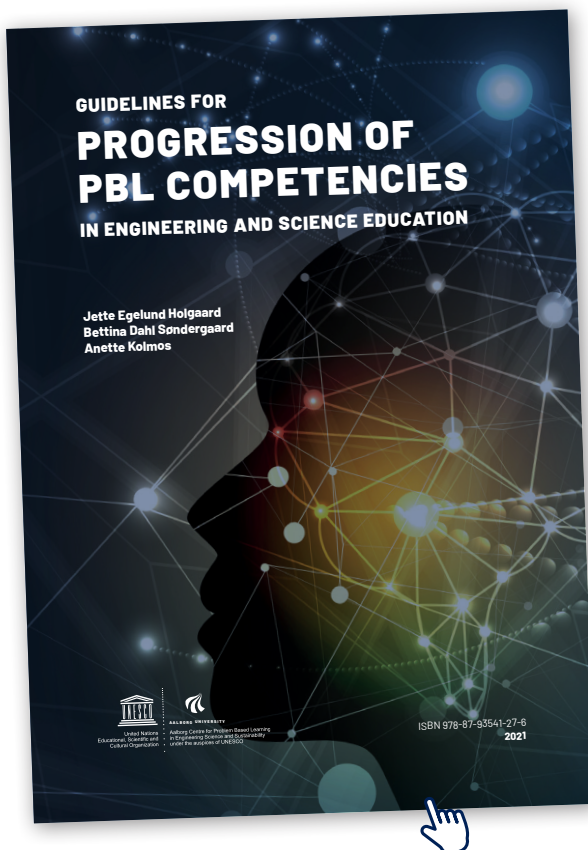
Once the ideas have been placed on the structure sheet, a progression check can be carried out to ensure, for example, that a theme introduced in the first semester is followed up sufficiently later on in the study – and vice versa. In addition, it has to be ensured that the students fulfil the ambition stated in the overall competence profile for the programme at the end of the study.

In the test version, the semester sheets are printed (in the colours of the theme card) and put together in a row (see the picture on the left).

In the prioritisation stage, some ideas are selected as core elements in the further formulation of PILOs for PBL, and they are collected on the black structuring sheet. The colour codes of the theme cards are thereby “mixed”, and it will be possible to see whether and to what extent the outcome of the prioritisation covers all four PBL competence areas. The thematic cards which relate to the prioritised areas are collected and, along with the qualification, activity and evaluation cards, they form the basis for formulating specific PILOs for PBL in the concretisation workshop.

To supplement this guide on how to facilitate staff in developing PILOs for PBL, you can find guidelines for progression of PBL competencies in engineering and science education here as well as dialogue cards and sheets to organise ideas here.

We hope that this guide as well as this additional material will inspire further work in your institution to raise attention towards progression of PBL competences as a way to strengthen generic competences in engineering as well as in other professions.



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