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# Emerging PBL Futures: Exploring Normative Scenario Development as an approach to support Transformation in Problem-based Learning and Higher Education

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## ABSTRACT

*Problem-based learning has a long history of transforming higher education institutions at course-, curriculum- and even systemic levels, and has shown to enhance student-centered learning and core pedagogical values such as facilitating collaboration, complex problem-solving skills and critical thinking. However, rapid digitalisation in higher education and emerging trends such as personalised life-long learning through micro-credentials and flexible curriculum models challenges existing, traditional onsite PBL practices and require new frameworks for envisioning future practice in higher education based on an understanding of its local context and the inclusion of multiple relevant stakeholders and practitioners, not only to co-create potential scenarios suitable for a particular educational institution but also in pointing to directions for initiating and maintaining this change process on a systemic level. In this paper, we propose normative scenario thinking as a method for educational development, and present the first steps and initial findings from a process of normative scenario development within a PBL university. The aim of this process has been to identify and explore key trends and core values that inform the development of future scenarios for the conceptualisation and implementation of PBL at the university, in a digital age. Through the analysis of a specific scenario related to project variation and reflection, we exemplify how a value-based and problem-oriented approach to exploring emerging PBL futures can facilitate systemic change in higher education.*

**Keywords:** PBL, scenario development, systemic change, higher education

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## INTRODUCTION

There is a call for change in higher education to address and respond to rapid digitalisation as well as increasingly complex current and coming societal challenges e.g. related to the Sustainable Development Goals and technological innovation. Thus, education and access to education is a strategic priority both in Europe and globally with student-centered and life-long learning approaches to skills and competency development increasingly emerging as trends in existing and emerging educational models and practice. The question is, how should universities respond to these challenges without risking an even more overloaded curriculum? What should be the long-term goals and the short-term actions? Student-centered learning as one of the overarching responses from higher education in the EU (Klemenčič, Pupinis & Kirdulytė, 2020) points to forms of active learning methodologies such as problem- and project-based learning (PBL) as the most dominant trend particularly within engineering education (Graham, 2018).

For traditional universities transforming along that change track, existing examples of PBL at course-, curriculum and institutional level has served as a platform for inspiration, research documentation and as living labs for visitors to learn about and experience alternatives to traditional teaching. However, PBL universities are already embodying student-centered learning and active learning methodology at a system level, and the question thus is, where do they look for practice to inspire for further development? How can they ensure continuous development and incorporate emerging trends such as digital transformation into their pedagogical vision and values?

In this paper, we discuss the application of value-based scenario development specifically within PBL institutions and present the first steps and initial findings from a process of normative scenario development as part of the research project PBL Future at Aalborg University. The paper presents the different phases in scenario development and demonstrate how a problem-oriented approach to identifying and exploring key trends and core values can inform and facilitate the development of future scenarios for PBL that are in line with its pedagogical vision while also facilitating systemic change in higher education.

## EXPLORING THE FUTURE: SCENARIO METHODS AND METHODOLOGIES

A scenario can be defined as a description of a possible future situation, including the path of development leading to it. The term was introduced in military and strategic studies by Herman Kahn in the 1950s, and was later used by corporations as a more sophisticated planning tool to analyse and understand key competitive decisions and to develop business strategies (Schwarz, 1991). Scenarios are not intended to represent a

full description of the future, but rather to highlight central elements of possible future(s) and to draw attention to the key factors likely driving the development (Bishop, Hines & Collins, 2007). Thus, scenarios are not predictions about the future but rather simulations of possible futures used to explore potentials and support decision-making, to highlight the discontinuities from the present and reveal choices available and their potential consequences (Kosow & Gaßner, 2008). A chosen scenario methodology describes the basic assumptions and process model, how the future is to be captured in the scenarios, and the methods through which the scenarios are formed, including the recommended support systems, modeling techniques, and data sources (Kosow & Gaßner, 2008). In this process, scenario methodologies apply a variety of methods depending on the scope, e.g. most 'probable'/'preferable' scenario. Although techniques vary, the scenario process tends to unfold in a similar manner across approaches (Kosow & Gaßner, 2008):

- In the first phase, the first step is to *determine the scenario field* by establishing the scope of the study and relevant questions to ask.
- In the second phase, researchers *identify key factors* that might influence how the future will unfold for further discussion with stakeholders and practitioners.
- The third phase analyses the range of outcomes these key factors could produce. This phase can be highly participatory and collaborative, informed by both research and practice.
- A following *fourth* phase involves condensing the list of central factors in order to generate a relatively small number of distinguishable scenarios.
- Finally, a *fifth* phase which then 'transfers' these scenarios to strategy and implementation

One of the purposes and uses of scenarios is to help decision-makers acquire knowledge and understanding to anticipate the context in which they have to act. However, for scenarios to be used effectively, the participants must be convinced of the soundness, relevance and value of the process. This is essential as the foundations on which scenarios are built, the structures that they use, and the reasoning they employ, must stand up to highly critical examination for it to contribute to decisions and actions (European Foresight Platform, 2020).

**Scenario Development and policy making in higher education**

In higher education, scenario planning as a tool has mostly been used in relation to policy studies (Amer, Daim & Jetter, 2013; Dator, 2002). On an international level, organisations such as OECD, UNESCO and national governments apply scenario methodologies for creating awareness and pointing out different possible future directions, focusing on the functions and societal role of the university as an institution.

For instance, in 2008 an OECD study pointed out four scenarios for higher education related to two dimensions: *national* versus *international* and *administrative supply driven* versus *market demand driven* (OECD, 2008). In this study, OECD identifies key drivers of change for each of the four future scenarios for higher education;

1) *Open networking* (based on partnerships and global higher education systems)
2) *Serving local communities* (focused on national/regional issues and publicly funded)
3) *New public responsibility* (involving new public management tools/incentives)
4) *Higher education Inc.* (driven by commercial interest and competition)

Today, all these types of universities do exist in glimpses and with tensions. On the one hand, there is a call for more globalisation like the Bologna process in Europe and on the other hand, national governments start to claim the use of national languages excluding international students in the programs. Private universities already exist, however a push for more privatisation such as School 42[1] is seen in recent years, both politically and from industry with the growing need for graduates with specific skills, particularly within computer science. Open networking scenarios are explored within projects such as the ECIU[2], however one could argue that a truly network-based higher education sector should include partners equally from all parts of the world to avoid polarisation.

Similarly to OECD, UNESCO creates policies for higher education and published a report in 2017 on Education for Sustainable Development formulating learning outcomes for each of the 17 Sustainable Development Goals with related interdisciplinary competences such as systems thinking, anticipatory competences, normative, strategic and collaborative competences as well as critical thinking skills (Rieckmann, 2017). These competences all represent a holistic future- and value-oriented approach, in which deconstructing disciplinary boundaries is considered key to facilitate complex problem solving. Another UNESCO study launched in 2015, *Future skills – The Future of Learning and Higher Education* is an ongoing project in which the third phase is based on a Delphi survey on skills and scenarios for future learning (Ehlers and Kellerman, 2019). In this study, four scenarios are built from students' perspectives:

1) the future skill university with increased focus on skills and competences rather than traditional knowledge acquisition
2) the highly digitalised and networked university where students will graduate with curriculum elements from various universities
3) the 'my university scenario' – or personalised curriculum – where students follow their interests and build a personal path
4) the life-long learning scenario for learners from workplaces where the universities offer micro-credentials.

The results of the survey point to the realisation of scenario 4 within five years, i.e. in 2020, and the realisation of the first three scenarios within a span of 10 years. A timeline that seems to have been further escalated by the sudden need for rapid digitalisation of teaching as a result of the covid-19 pandemic (Dhawan, 2020).

Whereas the two studies approach the question of developing future scenarios for education from different perspectives and apply different methods, they still point to common directions towards more flexible higher education system with a focus on skills and competency development, digitalisation allowing for new roles and types of industry-university collaboration, personalised curricula and life-long learning. However, at the same time they also highlight a potential tension within the education system itself, i.e. in the contradiction between a market-driven focus on skills and employability, and academic strategies of response to society's grand challenges which include a large focus on identity formation (Bildung) and critical thinking skills, pointing to the need for scenario development that combine both perspectives (Jamison et al., 2014).

**Value-based scenario development at institutional level**

Whereas scenario development within policy making in higher education will likely continue to rely heavily on trend extrapolation and quantitative data, scenario development particularly at an institutional level can benefit from a more normative-narrative or value-based approach. One example is the 'Near Future Teaching' project that applied scenario methodology to develop a shared value-based vision for the future of digital education at the University of Edinburgh (Bayne & Gallagher, 2020). As such, this project has served as an initiative to discover and create institution-wide awareness of the shared values and future directions for teaching and learning which is community focused, post digital, data fluent, assessment oriented, playful and experimental, and boundary challenging.[3] Thus, the application of participatory and value-based scenario methods is a creative and flexible approach to consider uncertainties and serve as a transdisciplinary tool for mutual learning, facilitating a sense of ownership and motivation for change among academic staff and students, and through this not only co-creating possible and preferable scenarios suitable for a particular educational institution, but also point to directions and processes for initiating and maintaining this change on a systemic level. Similar methods have been applied when developing new programs and new educational institutions, as is the case with e.g. Charles Sturt University[4] (Graham, 2018) and London Interdisciplinary School[5]. Here, new scenarios and even new digitally supported approaches to higher education is co-created with the involvement of academic staff, experts and stakeholders in response to an increasingly complex society and the need for new, interdisciplinary competences, student-centered learning environments and the development of life-long learning trajectories.

## PROBLEM-BASED AND INTERDISCIPLINARY PBL SCENARIO DEVELOPMENT AT AALBORG UNIVERSITY

Since its establishment in 1974, Aalborg University (AAU) has applied a problem- and project-based pedagogical approach combining traditional course formats such as lecturing, labs and exercises, online and blended courses with extensive team-based project work (50% of students' time) assessed by oral, group-based defenses (Kolmos & de Graaff, 2014). Research has documented the effects of PBL on areas such as motivation, retention, competence development, sustainability and employability (Dochy, Segers, Van den Bossche, & Gijbels, 2003; Strobel & van Barneveld, 2009). However, in the early 2000s a need for the development of shared visions and values for PBL was identified at AAU, as the local PBL practice had evolved with great variety across faculties and programs with little interaction and knowledge-sharing (Bertel et al., 2021). Thus, a process was initiated to further conceptualise the AAU PBL model and based on existing research and interviews with staff and students a shared set of guiding PBL principles for all study programs at AAU was developed (Aalborg University, 2015):

- The problem is the starting point of the learning process
- Project organisation creates the framework for problem-based learning
- Courses support project work
- Cooperation is a driving force in problem-based project work
- The problem-based project work of the groups must be exemplary
- The students are responsible for their own learning achievements

These PBL principles created a joint vision and a shared language of PBL throughout the organisation. However, to further support the development of a shared PBL practice, AAU allocated funding for a number of PBL initiatives as part of the university's strategy, including a significant number of local PBL development projects as well as a large cross-faculty research project on the future of PBL[6] (Bertel et al., 2021). One of the strengths of PBL is its inherent adaptability in the project-based approach to address complex and emerging problems in diverse contexts, with the combination of project collaboration and discipline specific knowledge to mirror the societal need for adaptable and transferable skills. However, though the AAU PBL model continues to receive international acclaim as a radical pedagogical innovation (Graham, 2018), PBL models also face an increasing number of complex challenges in the post-digital age. Emerging technologies and increasing demands from students, staff and external stakeholders to focus e.g. on employability, sustainability and life-long learning, require continuous revision and adaption of PBL practices on a systemic level. Thus, in 2017 AAU initiated *PBL Future*, an institution-wide research project, to facilitate a problem-oriented approach to the transition to digitally supported PBL and to the development of research-based directions and value-based scenarios for PBL in a digital age (Aalborg University, 2017).

**The PBL Future project: Determining the scenario field (phase 1)**

In a scenario development perspective, the PBL Future project construction in of itself constituted the first phase, i.e. identifying the *scenario field* consisting of a problem-identification process, in which a consortium of senior PBL researchers across the five faculties developed the project proposal, and an international expert advisory board was established, defining the scenario field and the purpose of the project, which is to:

> *"(...) re-conceptualise how PBL could operate in new formats, based on the core principles of PBL, while exploring and developing new digital approaches that operate in and open up for new hybrid PBL learning models." (PBL Future, 2021)*

**Identification of key factors (phase 2)**

In the second phase, the consortium identified preliminary *key factors* to influence the development of future scenarios based on the principles or core values of PBL at AAU. In this problem analysis process, these preliminary factors and values and their context were categorised divided into five subprojects; four subprojects (including four PhD projects) each addressing particular issues identified through the problem analysis, and a baseline study mapping out existing practices and understandings of PBL at AAU from student, staff and curriculum perspectives, and identifying key trends pointing to future directions (subproject 0). See figure 1 for an overview of the subprojects, key factors and core values (i.e. their relation to PBL principles).

| Subproject | Key factors | Values/PBL Principles |
|---|---|---|
| (1) Student-centered problem design | Student-centered learning<br>Increasing complexity<br>Sustainability | •The problem is the starting point of the learning process |
| (2) Emerging PBL collaboration skills for a digital age | Digital transformation<br>Global pandemic accelerating digitalisation | •Project organisation creates the framework for problem-based learning<br>•Cooperation is a driving force in problem-based project work |
| (3) Strengthening reflection and PBL competence development of individual students | Student-centered learning<br>Competency-based curricula<br>Life-long learning | •The problem-based project work of the groups must be exemplary<br>•The students are responsible for their own learning achievements |
| (4) Towards a PBL flipped semester approach | Digital transformation<br>Flexible curriculum<br>Life-long learning | •Courses support project work<br>•The students are responsible for their own learning achievements |
| (0) PBL competences – Baseline study and future directions | Digital transformation<br>Competency-based curricula<br>Student-centered learning | •PBL at systemic level<br>•Research-based teaching and PBL practice |

*Figure 1. Overview of PBL Future subprojects and related key factors and core values.*

**Analysis of the factors (phase 3)**

In the third phase of scenario development, *the range of outcomes* that the key factors could produce are examined. This phase can be highly participatory and collaborative, informed by both research and practice. In the PBL Future project, the approaches and methods applied in the individual subprojects all contribute to the exploration of key factors and core values related to that particular subproject for further elaboration in the consortium. In subproject 1 and 2, different forms of ethnography (video and digital) and situational analysis were applied as methods for exploring student-centered problem design and collaboration processes through the duration of a semester project (Thorndahl et al., 2018 and Ryberg et al., 2018). Subproject 3 and 4 applied participatory methods and co-creation workshops to develop new approaches to course design and methods for supporting student reflection and individual competency development (Lolle & Scholkmann, 2021 and Kofoed et al., 2019). Subject 0 applied surveys, quantitative content analysis and statistical instruments to investigate PBL competences from student-staff- and curriculum perspectives. As the PBL Future project addresses questions specifically related to researching PBL as an institutional phenomenon, measures were taken to include and capture the complexity of PBL through case studies in multifaceted (physical and blended) learning spaces as well as to ensure that data from all faculties and research units were represented.

In this third phase, the consortium explored data and findings from phase 3 to further expand each key factor and core value through workshops, resulting in a visualisation of the variations within each of the existing PBL principles (figure 2) serving as a tool for developing and choosing distinguishable scenarios for further exploration.

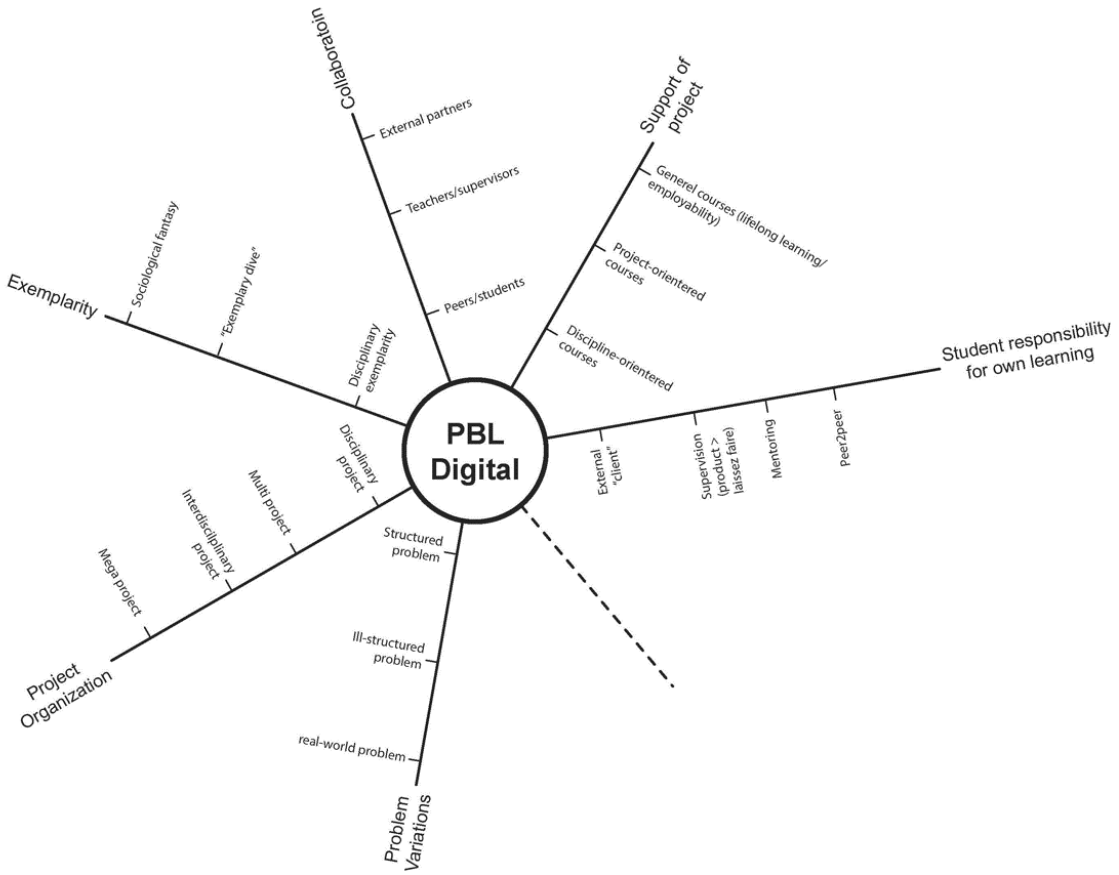


*Figure 2. Analysing variations within the value-based scenario field of PBL at AAU.*

In this process, each PBL principle was projected through 'factor funnels' (Kosow & Gaßner, 2008), a funnel-shaped span of possible developments of this particular principle, together forming the joint space of possible, plausible and preferable (PBL) futures for these factors in the scenario field. Upon deconstructing and expanding each of the existing principles into dimensions of PBL, eight new guiding principles with for the PBL Future scenarios emerged (figure 3) with *variation* (between these scenarios) as an emerging core value connecting them:

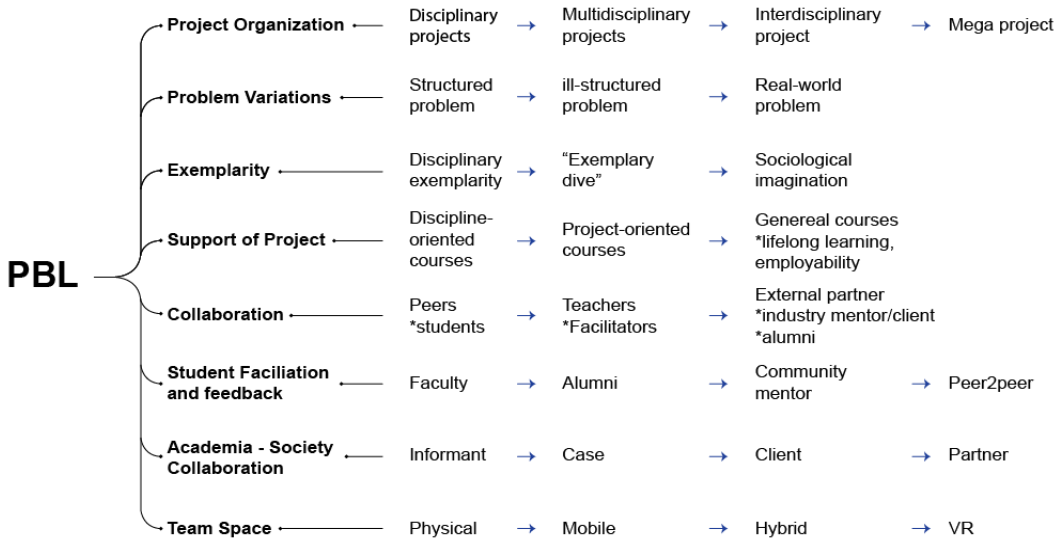


*Figure 3. Overview of emerging principles and related scenarios after initial analysis. Scenario generation (phase 4.)*

The PBL Future project is currently in its fourth phase, where the condensed list of key factors and core values has been further conceptualised into 'general' and 'specific' principles for PBL in order to generate a relatively small number of distinguishable scenarios for practical experimentation and potential implementation. In the following, we will exemplify this process by diving into the condensed principle of project variation and describe distinguishable scenarios developed for this particular key factor and discuss this scenario in relation to the aforementioned future scenarios for higher education described by OEDC and UNESCO.

## PROJECT TYPES AND CRITICAL THINKING SKILLS: VARIATION IN THE PBL EXPERIENCE AS A CORE VALUE

Whereas project-organisation is has been a guiding principle for PBL at AAU across all faculties and programs for many years, the key factor analysis in phase 3 showed local variations, i.e. in the ways in which students work with problem identification (Velmurugan, 2019); the way they organise themselves and their collaboration processes online and onsite (Ryberg, Sørensen & Davidsen, 2018); their experiences with competency development in the projects (Scholkmann, 2017); and the ways in which courses support project work (Kofoed et al., 2019). Results from the baseline surveys support this, with both students and staff emphasising project group work, and particularly digitally supported interdisciplinary group work, as important for the future of PBL at AAU (Clausen & Kolmos, 2019). However, the baseline curriculum content analysis also show, that the standard discipline-specific semester project is still most common at AAU, with little variation in project-size or timespan (Boelt, Clausen & Bertel, 2019).

A similar trend is seen in the PBL literature with an increasing prevalence of project activities, however often characterised by problems given by teachers, projects that run for a semester or a throughout the duration of a course, and with smaller teams of mostly three to eight students (Chen, Kolmos & Du, 2020). However, if students experience repeating patterns of project work throughout their education without reflection on differences and similarities, there is a risk of it becoming routine and the knowledge, skills and competences associated with it, tacit. Thus, facilitating reflection on the experiences of variation e.g. in type of problems and projects, can support students in articulating contrasts, similarities and differences and thus make explicit their PBL competences, including critical thinking skills. We propose this can be done in two ways; by implementing a more systematic practice of reflection regarding project work and competences (Holgaard & Kolmos et al, 2019), and by developing more diverse project types that vary in complexity of scientific scope and (online/onsite) structure (Kolmos et al., 2020).

Developing diversity and variation in scientific complexity can involve scaling up the scientific scope by expanding the range of project types from single disciplines to multi- and interdisciplinary projects, in principle determining choice of discipline and method to match a similar range of narrow discipline specific to complex interdisciplinary problems (Kolmos et al., 2020). Similarly, developing variation in complexity of project structure can involve scaling up the collaboration from a handful of students within a team, to teams of teams collaborating in a networked structure (Routhe et al., 2021). Within the two dimensions; *interdisciplinarity* and *teams in networks*, four basic project scenarios were identified (Kolmos et al., 2020);

- *Single-discipline projects* carried out in single project groups, widely used both at course and curriculum level, where students within the same educational program apply discipline-specific knowledge/methods, skills and competences to a discipline-specific problem
- *Interdisciplinary projects*, which can be carried out in one project group composed of students from different disciplines or as a single discipline group 'borrowing' methods and concepts from other disciplines to address an interdisciplinary problem. Initial problem analyses are often interdisciplinary in scope, with students often integrating interdisciplinary methods to identify user needs in otherwise discipline-specific projects
- *Multi-projects*, which occurs in bigger courses or clusters of sub-disciplinary courses, and is characterised by a number of project groups working on the same or complementary elements (work packages) within the same or similar disciplines. These types of projects require (digitally supported) coordination among project teams to ensure the quality and feasibility of a common product and/or problem-solving method

- *Megaprojects*, which covers large, long-term and highly complex interdisciplinary projects (broad or narrow interdisciplinary) e.g. supported by an interdisciplinary team of supervisors, with great collaborative complexity in digitally supported networks of teams responding e.g. to global crises such as the COVID-19 pandemic or grand challenges related to the sustainable development goals.

Whereas this distinction in project scenarios is made for prescriptive purposes with real-life practice providing many more variations, the exploration of the scenario field within project variation also showed that all four categories of projects were already present or emerging in practice, but lacking a systematic practice for reflection on variation in the PBL experience and progression in associated PBL competences.

**Emerging AAU Megaproject scenarios: Dissolving disciplinary boundaries through digitalisation?**

To explore and further develop the megaproject scenario, students, staff and stakeholders were involved in piloting AAU Megaprojects[7] in 2019-2021, with three megaprojects: *'Simplifying Sustainable Living', 'The Circular Region'* and *'Better Together'* with approximately 80 students total participating in clusters of groups working together through an online platform to solve challenges related to the above themes.

PBL Future followed the process, and found that the concept was indeed addressing specific factors related to student-centered learning and student engagement and provided the opportunity for variation in the PBL experience and complexity of problems (figure 4).

| Scenario | Key factors | Values/PBL Principles |
|---|---|---|
| AAU Megaprojects | Student-centered learning (flexible curriculum, networked learning)<br>Increased complexity (sustainability/interdisciplinarity)<br>(Digitally supported) collaboration | •Variation in the PBL experience<br>•The problem is the starting point of the learning process<br>•Students are responsible for their own learning |

*Figure 4. Key factors and core values initially addressed in a Megaproject scenario.*

However, we also found that adjustments and improvements of the setting and structures were needed to support other relevant values and principles, e.g. related *to project organisation and team space*, i.e. the interdependency between projects in the network (Routhe et al. 2020) as well as interdisciplinary *facilitation and support* of the project and *progression and assessment* (Bertel et al., 2021), pointing to a need for more feedback and ongoing assessment of both the projects' process and its products, as well as digital tools and methods through which students can articulate and document knowledge, skills and competences developed through the megaproject. This way, empirical findings from the piloting of megaprojects provided insights into potentials and challenges specifically related to variation in the PBL experience as a core value at AAU.

Another key factor that the initial megaproject scenario did not anticipate was the rapid digitalisation of course content and project work that took place in spring 2020 and onwards due to the covid-19 pandemic and the resulting lockdowns. On the one hand, this provided access to more interdisciplinary knowledge, skills and competences and enhanced the principle of courses supporting projects, but on the other hand also escalated the complexity of the collaboration, bringing tensions between the principle of *problems as point of departure for learning* and the discipline-specific learning outcomes in the formal curriculum. In this way the normative scenario development process and the problem-based approach to exploring potentials and challenges in megaprojects continue to mutually inform one another, and a new megaproject concept further emphasising digitally supported reflection, feedback and assessment has been developed through scenario workshops in the fall of 2021 and is expected to launch in 2022.

## POTENTIALS AND LIMITATIONS IN NORMATIVE SCENARIO DEVELOPMENT FOR CHANGE IN HIGHER EDUCATION

Whereas the trend extrapolation in scenarios for higher education such as those proposed by OECD and UNESCO are based on somewhat verifiable calculations and thus represent a certain global probability across contexts, a normative scenario development process as shown above has the possibility of incorporating the participation of many different actors with no restrictions in terms of the number of factors to potentially be taken into account. However, at the same time normative scenarios also tend to be particularly selective (and provocative) 'wish'-scenarios that are not necessarily easily implemented, and the process is resource-intensive.

The scenarios emerging from the normative scenario development process address similar issue as those highlighted in trend extrapolation, i.e. an increased focus on skills rather than knowledge acquisition, a highly digitalised and networked university and personalised curriculum, as well as a multitude of life-long learning trajectories through which industry and academia can collaborate (online and onsite) to solve the global and grand challenges of tomorrow, but the normative approach also attempts to link these to critical thinking skills and PBL competences, thus the added value of this approach is in the integrated and transparent connection between specific scenarios and pedagogic principles, pointing not only to important contextual values but also to paths for scenario transfer and future implementation.

## CONCLUSIONS AND FUTURE WORK

In this paper, we presented the first steps and initial findings from a process of normative scenario development in PBL Future – an institution-wide research project to develop PBL for a digital age at Aalborg University. Through the analysis of the scenario field and related key factors and core values, digitally supported project variation was chosen as a distinguishable scenario to exemplify how a problem-oriented approach can be used to explore emerging and digitalised PBL futures. The initial results show, that normative scenario development can connect significant emerging trends to current and emerging practice, pointing not only to contextual and core values but also to paths for scenario transfer and future implementation. In future work, other scenarios developed through the PBL Future project will be piloted and further analysed for applicability and implementation in relation to the current strategy for PBL at Aalborg University as a mission-driven university, and normative scenario development further explored as an institutional approach to develop and transform current and emerging practices in PBL and higher education on a systemic level.

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