



A Review of Aalborg University's Problem-Based Learning (PBL) Model to Achieve Sustainable Development Goals

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ABSTRACT

This paper introduces Aalborg University's "problem-based, project-oriented" PBL education model, analyzes Aalborg University's five departments, campus services and innovation, and gives examples of Aalborg University's activities in the research, teaching, management and operation of 17 Sustainable Development Goals. Aalborg University's experience shows that sustainability should become a core part of the university's activities and become a mission-oriented university that fulfils the three major functions of talent cultivation, scientific research and social services and contributes to the sustainable development of the environment, society and economy of the world.

Keywords: Aalborg University, PBL education model, Sustainable Development Goals

The 2030 Agenda for Sustainable Development was adopted at the 70th UN General Assembly in 2015 (Transforming our World: The 2030 Agenda for Sustainable Development (SDGs) calls on all countries to take active actions to achieve 17 Sustainable Development Goals (SDGs) in the next 15 years. The 17 Sustainable Development Goals (SDGs) proposed by the United Nations are interconnected and will have a significant impact on world strategies and actions in multiple areas, providing guidance on how to address the world's most pressing and critical challenges. These challenges are complex and require action from all social actors. (SDSN Australia, 2017) Knowledge institutions like Aalborg University play a vital role in this effort, and sustainability is an integral part of Aalborg University's activities, as well as in the new 2022-2026 strategy and the balanced and sustainable development policy to be developed in 2020. The 2022 Times Higher Education World University Rankings include the implementation of the Sustainable Development Goals as part of the ranking indicators. (THE World University Rankings, 2022) In the 2021 Times Higher Education Impact Rankings, Aalborg University is ranked 6th out of over 1,200 universities in 98 countries, with a focus on Sustainable Development Goals (SDGs) performance, which proves that Aalborg University has made some progress in sustainability and the SDGs.

I. Core Concept and Characteristics

Compared with the traditional teacher-lecture-based teaching model LBL (Lecture Based Learning), the PBL education model is a problem-based and project-oriented learning model, that is, starting by raising a Problem. It aims at planning, managing and completing research projects, that is, solving the problems raised. (Tao d. y., 2015)The characteristics of the PBL education model are mainly embodied in the aspects of focusing on problem project-oriented, guiding students' independent inquiry, advocating team cooperation, encouraging interdisciplinary integration, and paying attention to students' multiple feedback.

1. Focus on Problem-Project-Oriented Education

The core concept of the PBL education model is "problem-based, project-oriented".Around the project theme, students work in groups to construct questions independently, which can come from book theory or practice, and solve problems by exploring questions one by one and improving students' analytical ability. During the implementation of the project, the students made continuous planning and adjustment, division of labour and cooperation within the team, kept smooth

communication with the teacher, and finally formed the project report and defence in the group. In the PBL education model, guiding students to discover, analyze and solve problems independently can cultivate students' love for learning, stimulate students' motivation for learning from the inside out, and improve students' ability of independent management, logical thinking and language expression. The PBL education model will connect each problem and project in series, so as to build an educational model suitable for students' development law.

2 Guide Students to Explore Independently

Our higher education mostly adopts the traditional way of indoctrination. "The good gentleman is not to teach, not to teach, but to teach students to learn, to teach so as not to need to teach, to teach not to teach." (Tao x. z., 2008). The PBL model emphasizes students' independent inquiry. Autonomy is embodied in mobilizing students' subjective initiative, actively dealing with the problems encountered in the course learning, not only to become the problem proposer but also to become the problem solver. Inquiry is reflected in that students explore and test knowledge through collecting literature materials, participating in observation, questionnaire surveys, designing experiments, etc., so as to acquire new knowledge and cultivate the ability of scientific exploration. Of course, it should not be considered that problem-solving is a very simple task that can be completed once. The experiment may be based on many trials and errors to get the correct and effective results.

3. Advocate Teamwork in a Small Group

A prominent phenomenon in the current education teaching is that students do not pay enough attention to individual combat, solidarity and cooperation. PBL model advocates collaborative solution, which can overcome the drawbacks of atomization in traditional teaching to a certain extent. "Collaborative learning is different from ordinary teaching activities. We cannot presuppose the specific sequence of students in the collaborative learning process like designing ordinary teaching plans. "Because of their different personalities, thinking conditions and life experiences, students will have different perspectives on things, perspectives on understanding knowledge and dimensions of problem-solving. In the real life of learning, many problems can not be solved by individual buildings behind closed doors, so many students need to form a team and work together to design a reasonable solution. In 2020, according to the spirit of the PBL approach, Aalborg University's seminar room was designed in a new and innovative way, transforming the traditional setting of long rows of stools and tables into a group-oriented interior design. The design process involved the participation of students and faculty. PBL seminar rooms provide teachers with a flexible approach to teaching that shifts from seminar to group work and back again. The PBL seminar room enables students to work in small groups after a seminar. The dynamic function of the seminar room saves square footage, thus providing complete functionality for teaching, group work, etc.

4. Encourage Interdisciplinary Integration

At the present stage, there are three common modes of interdisciplinary teaching: collective teaching by teachers in different fields, integration of some specialized courses, and new courses with interdisciplinary characteristics. The first is that teachers often lack effective cooperation, and students are still presented with fragmented knowledge. The latter two kinds of knowledge are integrated by course designers in advance and then imparted to students, which have obvious characteristics of a knowledge center. (He, Liang, & Pang, 2021) On the other hand, AAU-PBL believes that

interdisciplinary knowledge integration should be undertaken by students rather than teachers, and it is not realized by students directly learning static "interdisciplinary" knowledge, but by students integrating and applying the knowledge of various disciplines in the process of analyzing and solving problems. Therefore, it takes problem analysis and solution as the basic form of learning, enabling students to use multidisciplinary knowledge and methods in a comprehensive manner.

To analyze and solve specific problems, through this form to achieve effective interdisciplinary integration. According to the multiple subject fields involved in the project, students from different majors and disciplines are cross-combined, which can not only help students test the theory in practice, but also give full play to their imagination and creativity in a diversified team and enrich the practical direction of the theory.

5. Pay Attention to Students' Diverse Feedback

Teachers pay attention to the imparting of knowledge but ignore the summary after class. Students listen carefully in class and rarely review after class, which has become the normal situation in the school. "Nowadays, university education emphasizes taking practical problems encountered in the teaching process as research objects, and advocates that all class participants become action researchers and reflective practitioners." (He, Liang, & Pang, 2021) The PBL model has a section dedicated to summarizing and reflecting on the learning process. This step is crucial. Reflection is a way to sort through past learning, identify deficiencies, and improve on them. At the same time, the PBL model also pays much attention to scientific evaluation, which is different from the traditional way of focusing on the result evaluation. This science is mainly reflected in the importance of students' self-evaluation, mutual evaluation and teachers' evaluation and feedback.

II. Strategy

Aalborg University's Sustainability Report 2021 shows that Aalborg University staff have contributed to the sustainability of all 17 SDGS and that their efforts have had an impact at the local, national and international levels, and have had an impact on all generations of people, including children, young and old. Aalborg University's strategic goal is to create knowledge for the world. (Aalborg University , AAU-Sdg-Report-2021-v6 , 2021) In the new strategy, this ambition is strengthened and made more explicit. The 'Knowledge of the World 2022-2026' articulates Aalborg University's vision as a nationally recognised mission-driven university that contributes to sustainable development, with sustainability as a core part of all activities. (Aalborg University, AAU-Strategi-2022-26, 2022) Aalborg University's PBL approach to promoting the Sustainable Development Goals is explored from three dimensions: talent cultivation, scientific innovation and social services.

(i) Talent Cultivation

1. Identify Sustainable Development Goals

Aalborg University is an ambitious university with goals that extend far beyond its walls to the heart of the most pressing global and local trouble spots. The energy of the future must be part of the solution to major societal challenges. Energy is fundamental to the human condition. Sustainable development is an integral part of Aalborg University's Bachelor of Energy program, which includes sustainable and climate-neutral energy production and the development of economically sustainable energy solutions. It contains content in the fields of thermal energy, electrical, control and

mechatronics. Starting from the fifth semester, the course of study is divided into three majors. Students study basic energy technology issues and the development of sustainable energy systems, leading to the ability to plan, produce, distribute, and consume electricity, heat, or mechanical energy, as well as the ability to control energy technology systems. Access2Innovation, a spin-off of Aalborg University, is Denmark's innovative, sustainable, commercial solution for emerging markets in Africa. Africa is home to a wealth of natural resources, including young people who find themselves unemployed or underemployed, regardless of their level of education. Higher education institutions (HEIs) on the continent face challenges such as not being well connected to the wider socio-economic context, textbook-based curricula that do not address local socio-economic issues and needs, and outdated teaching methods. The research project of the Planning Department of Aalborg University aims to reform the higher education (HE) study programme to ensure that the curriculum is highly relevant to the contemporary economic and social needs of Africa, and equips graduates with employability and self-employment skills and abilities.

2 Adopt the PBL Approach

Aalborg University has adopted a PBL approach, redesigning the learning curriculum and incorporating entrepreneurship, innovation, and environmental, social and economic sustainability. The Sustainability Report of Aalborg University 2021 shows that work that contributes to sustainability is widely supported at Aalborg University. All faculties contribute in terms of teaching, curriculum and knowledge collaboration. In the School of Information Technology and Design Technology, to create the highest level of knowledge for the world. PBL-based learning and research are widely recognized both inside and outside Denmark, including the distinction of being named the best engineering university in Europe and the fourth-best university in the world for engineering programs. The approach to creating knowledge for the world includes a strong focus on sustainability. Help create a sustainable future for future generations through degree programs, task-based research and close collaboration with stakeholders around the world. Efforts in sustainability are combined with another major area of focus: digitisation - to achieve the goal of digitisation by increasing the digitisation capacity of all courses and by providing Danish companies with a bespoke, research-based digitisation push, thereby shortening the overall pathway to sustainability through a digital approach. These learning courses enable students to find solutions to create a sustainable future. In the bachelor's program, students' projects focus on issues such as planning affordable and climate-neutral urban areas, business and industry with minimal negative impacts, and holistic and resilient building and natural infrastructure. In the master's professional program, students study how to create stronger urban environments and quality, based on the concept that cities are more than the sum of their parts. This holistic, multi-disciplinary and participatory approach places people at the centre, enabling students to focus on creating benefits and quality of life for all occupants and users. In addition, from September 2022, Aalborg University will welcome new students to a brand new course on sustainable building processes. Thus, graduates of these courses, both during their studies and as professionals, contribute to translating Sustainable Development Goals into social action.

(ii) Scientific Research

The SDGs cannot be achieved without knowledge convergence and innovation. The COVID-19 pandemic, communication and social emergency as well as a health crisis, highlights the need for interdisciplinary expertise more than ever.

1. Integrate Communication Across Disciplines

Aalborg University supports the use of re-searching, new knowledge, invention and entrepreneurship, ranging from collaborative agreements, financial support and doctoral enrollment to commercialization, student entrepreneurship and collaboration with stakeholders, private companies and the public sector. It participates in regional, national and international collaborations, such as national clusters and the International Innovation Cooperation Network; CESEAR and ECIU. Engage in partnerships to provide strong support for approaches to achieving the SDGS; For example, working with municipal governments, regional offices, regional hospitals and health technology partners to support good health and well-being or regional sustainable development partnerships. In the fight against climate change, Aalborg University places a high value on research and collaborative activities with companies and other organizations, with multiple research groups highly specialized in climate and environmental challenges to promote green transformation. This puts 15 percent of Aalborg University's research articles in the field of green research, which is considerably higher than the average of other universities, giving it a particular advantage in research on green energy and green transportation, with researchers from the university accounting for more than a third of all research articles in Denmark.

In the Faculty of Engineering and Science, excellent research is conducted in the fields of engineering and science, striving to provide valuable knowledge as an important contribution to sustainable solutions to societal challenges. There is a special focus on nine areas of sustainability across the school's strongholds. These areas contribute to the sustainable development of society and address local, national and international sustainable development agendas (e.g., the Danish Climate Law, the Danish Government's Green Research Strategy, the European Union's Vision for Europe Programme and the UN Sustainable Development Goals). Students from the Faculty of Engineering and Science have the opportunity to collaborate with students from other programs in the faculty. We call these interdisciplinary student projects leadENG Projects. The leadENG program complements the sustainability profile of the School of Engineering and Science and is based on nine focus areas of sustainability. The aim of the leadENG programme is to improve students' understanding of their subject area and how it can be applied to related subject areas - all in response to society's great challenges.

2. Creation of the PBL Institute for Advanced Studies

On 1 January 2022, Aalborg University opened a new interdisciplinary teaching and research unit in Problem-based Learning (PBL): the Institute for Advanced Problem-based Learning, which integrates the university's unique research in the main areas of PBL. Problem-based learning is at the heart of the university's approach to teaching and learning, and the problem-based learning model provides the foundation for Australian universities to enable students to learn by solving real problems and is recognized nationally and internationally. The new PBL Institute for Advanced Study aims to enhance and advance problem-based learning, enabling the university to remain a national and international leader in PBL teaching practice and research. With the university's leading re-researchers in problem-based learning, and the opportunity to use the University's educational environment as a laboratory for teaching experimentation, the university will be able to develop and support new cutting-edge capabilities in its research courses and future graduates. This may include special tactical considerations relating to digitisation or incorporating STEM into the course of study.

Aalborg University ensures inclusive and equitable quality education and promotes lifelong learning opportunities for all. Local children and young people are trained to prevent sports injuries and sports researchers from the Department of Health Sciences and Technology have launched the concept of "re-searching for Everyone" (in Danish. forskningsøjnehøjde"), a free service for children and young adults who wish to learn more about sports training, training loads and injuries - particularly knee injuries and pain. Participants' movements are measured and their knees were examined; They were also given the opportunity to participate in a research project where researchers examined and tested the knees under various training loads. Thus, the service contributes both to strengthening the prevention of knee injuries and to empirical research in the field. Apart from this, the Ministry of Culture and Learning's Capacity Building and Evaluation (CaBE) and the research group of the Center for Educational Policy Research (CfU) conduct practice-based research in education, pedagogy and assessment, with a special emphasis on the quality of daycare and schools. Research is conducted in collaboration with practice, which ensures immediate implementation and social impact of research findings. Currently, CfU is working on the Sapere Aude project with partners in Denmark, Argentina, the United Kingdom, Israel and China to study testing and inclusion. The KIDS 0-18 platform supports the articulation of research and practice by disseminating research findings, conferences, news and other activities to partners and stakeholders, thereby shaping research and facilitating the local testing of research results.

(iii) Social Services

Aalborg University participates in local and regional industries, is an active partner in regional development, has reached strategic development agreements with regional governments on infrastructure for green transformation, and pays special attention to securing more students in STEM fields in order to train the workforce for local industries. In addition, the AAU serves on various local industry committees, such as the Aalborg Business Council, the committees of clusters and business support organizations.

1. Actively Cooperate with the Government

In September 2019, Aalborg University and Aalborg Zoo expanded their cooperation to further utilize research and teaching in animal welfare and species conservation. The agreement is fully in line with Aalborg University's strategy of "knowledge for the world" and is an ideal example of Aalborg University working with society to create knowledge. A part of the agreement allows biology students from the Faculty of Engineering and Science to work at Aalborg Zoo, which strengthens their research projects and makes them more detailed. In addition to working closely with researchers and staff from Aalborg University and Aalborg Zoo, the students can also practice their communication skills when presenting their results and findings to zoo visitors. This is a good way to improve knowledge sharing, enabling research and results to be known and seen by the outside world. In addition, Aalborg University is heavily involved in cooperation with the Danish Energy Group. The Danish Energy Cluster is the cluster organization of the Danish energy system. Strategic research partnerships with small and medium-sized companies, global companies and public organizations provide superclass energy solutions for the transition to a climate-neutral and fossil-free society. Researchers at Aalborg University co-create with ECD members in energy production, storage, efficiency and systems integration.

Aalborg University's Membrane Technology Centre (CMT) provides a unique platform for

research and knowledge sharing and supports research into membrane separation. The organization includes researchers from several departments of Aalborg University: Departments of Chemical and Biological Sciences, Electronic Systems, Built Environment (BUILD), and Energy of Aalborg University. The center emphasizes interdisciplinary cooperation to find innovative and sustainable solutions for water treatment and resource recycling. The center was created in collaboration with other leading universities and companies across the globe. The center's mission is to generate synergies in membrane research by bringing together expertise in membrane development, control and monitoring, process design and scaling up in one platform.

2 Revitalize the Sustainable Development Relationship

Aalborg University is actively committed to building strong partnerships at the local, regional, national and international levels. Aalborg University's roles in partnerships aimed at solving highly diverse problems of different scales include international cooperation, a collaboration between businesses and Aalborg University researchers and students, and leasing or allowing access to Aalborg University research facilities and equipment. There is information that Aalborg University leads the way nationally when it comes to the amount of collaboration based on the size of the university. These collaborative programs have been documented to create value for external partners, not only in business and re-researcher cooperation but also in student programs. First, Aalborg University and Arctic build knowledge, engagement and capacity through collaboration. In recent years, the Arctic has become a symbol of climate change. Climate action and green transition as a partnership of shared responsibility is a prerequisite for addressing these challenges. Research, teaching and collaboration are areas that everyone, regardless of nationality or background, will look at and agree are relevant to achieving Sustainable Development Goal 13. AAU Arctic was established in 2016 as a cross-collegiate platform to work together with researchers and students in Greenland, the North Atlantic and the wider Arctic, as well as stakeholders and communities, to co-ordinate, promote and communicate Arctic research and collaboration. Second, Aalborg University collaborates with the Danish Green Centre on a number of national mission-oriented initiatives, such as Inno-Missions and "Growth Team" in Northern Denmark, and is an active partner in projects such as Sustainable Synergy, GreenCem and DanWEC. Finally, CESAER is a strong and unified voice for more than 53 universities of science and technology in Europe. Aalborg University is involved as a board member and chair of the Working Group on Learning and Teaching, as well as participating in several other working groups that provide the opportunity to influence key institutions, participate in European funding programmes and promote society's understanding of science and technology for a sustainable future.

III. Conclusion

By transforming education, research and social services, and combining the strengths of its PBL model, Aalborg University contributes to the achievement of the Sustainable Development Goals at the national, regional and global levels, as well as driving its own transformation and development. Aalborg University's experience shows that in order for a university to promote the realization of Sustainable Development Goals, it is indispensable to establish a concept and explore a practical approach. Universities should lead society to fully reflect on issues such as global conflicts and environmental pollution, convey the importance of sustainable development to society, and give an in-depth interpretation of sustainable development. Research in universities should focus on achieving Sustainable Development Goals, and researchers need to actively participate in relevant scientific

research projects to produce knowledge. Provide funding, equipment and personnel for research related to the achievement of the SDGs, and introduce relevant research incentives to encourage more research teams to actively participate in research related to the achievement of the SDGs. Universities should rely on the advantages of their resources and platforms, give full play to their influence and radiating role, establish extensive partnerships with governments, non-government sectors, enterprises and the public, and drive the whole society to build a community for realizing the SDGs. To achieve the SDGs, universities should actively participate in global governance and play a greater role in the governance of public affairs at the local, national and global levels.

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