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OVERVIEW OF WORKSHOP

This workshop will demonstrate how Challenge Based Learning (CBL) is a transformative pedagogical practice for change leadership in education that leads students to solve industry and society problems, to direct the course of their learning and puts the teacher in the role of coach and guide. It cultivates an active and authentic learning environment that requires students' creative input, collaboration, and community involvement(Tang & Chow, 2020). CBL was developed in the USA by Apple in 2008 as part of a collaborative project called 'Apple Classrooms of Tomorrow'.(Nichols et al., 2016). It is a multidisciplinary, collaborative approach to teaching and learning that encourages participants to solve industry and society problems. (Johnson & Adams, 2011).

With the rapid development of scientific and technological knowledge, engineering education has shifted from practical engineering instruction to engineering science instruction. In recent years, the industry has discovered that graduating students are technically competent but lack numerous competencies in real-world engineering scenarios. Further, this rapid scientific and technological development that is happening globally at an ever-increasing pace has caused many traditional universities that are not agile to lag behind the industry. The university curriculums are just not evolving fast enough to stay ahead of the technological development occurring in the industry. This is a paradox. Universities are still ahead of the industry in terms of generating new scientific knowledge through research. The issue is that not much of this new knowledge gets eventually introduced by the faculty staff into their curriculum in a meaningful manner. More spillover of research results into teaching is needed to maximise the value creation of scientific research (Membrillo-Hernández et al., 2021, Conde et al., 2021).

CBL can be perceived as a development of the Conceive, Design, Implement, operate (CDIO) concept, thus facilitating deeper learning experiences. It is highlighted that for redirection of engineering education, engineering graduates need more solid skills in team working, leadership, communication, collaboration, creativity, entrepreneurship, sustainability (Crawley et al. 2014). Therefore, engineering education need consider a learning experience that can develop skills that are not usually developed in traditional engineering education.

Challenge based learning (CBL) relates to curriculum change and agility as it is a flexible learning model that over the past 10 years, has been widely applied and tested in various levels of education, from elementary school to the baccalaureate stage. CBL also has implications at a macro level as it links educational practice to the development of professional skills and a greater awareness of broader societal and global issues to drive change. Nevertheless, the curriculum-based use and implementation of CBL remains an underexplored and underrepresented area of research and therefore we want to disseminate its benefits to

HE colleagues through this workshop. By joining the CBL workshop, participants will learn how to implement this new pedagogical approach in the structure of a course within the CBL framework, which can connect education to local industry and society.

For this workshop we propose as a 'big idea' Curriculum Agility as it is sufficiently broad to attract and engage participants from a wide range of disciplinary backgrounds. It is a highly topical issue within the higher education sector that has the potential to generate a rich and creative discussion. By participating in this workshop, participants will learn how to implement CBL framework in the engineering course through experiencing it themselves and working in Teams by working on different challenges in engineering education.

KEYWORDS

Standard 3: Integrated Curriculum, Standard 9: Enhancement of Faculty Competence, Standard 10: Enhancement of Faculty Teaching Competence

DURATION

The workshop will be 120 minutes long. The structure and timings are outlined below:
Facilitators: Yihan Xing, Fiona O'Riordan and Masoumeh Shahverdi

Location: Location:University of Science and Technology (NTNU). Campus: Gløshaugen, Building: Realfagbygget

Roles:
Team facilitators: Fiona O'Riordan, Yihan Xing and Sanaz Masoumeh Shahverdi

Time	26th Jun	Duration	Responsible:
	ENGAGE - The big idea		
09:30 - 09:45	Presentation: Introduction to Challenge Based Learning and the Engage Phase	15 min	Fiona, Sanaz
09:45 - 09:55	Teamformation	10 min	Team facilitators
	INVESTIGATE		
09:55 - 10:10	Presentation: Introduction to the Investigate phase (Fish Technique)	15 min	Sanaz, Yihan
10:10 - 10:35	Team work	25 min	Team facilitators
10:35 - 10:40	Break	5 min	
	ACT		
10:40 - 10:55	Presentation: Introduction to Act phase (Six Thinking Hats)	15 min	Sanaz
10:55 - 11:15	Team work	20 min	Team facilitators
	Team presentations		
11:15 - 11:25	Team pitches and presentation, 2 min. Pitch	10 min	Team facilitators
11:25 - 11:30	wrap up the workshop	5 min	Team facilitators

ACTIVITIES

Participants will be introduced to each of the three stages of CBL (outlined below) before engaging in Team work to gain a practical understanding of how to implement each stage.
At the end there will be a wrap-up presentation with an opportunity to reflect on shared learnings of the workshop.

CBL has three distinct phases, ***Engage, Investigate and Act.*** The workshop begin with the **Engage** Phase which moves from the Big Idea to a concrete and actionable Challenge by using the essential questioning process (Swiden, 2013). In the **Engage phase** participants is given a 'Big Idea: Curriculum Agility' as the foundation for their challenge, an essential question: *How do we improve engineering education to produce highly employable engineers,* **and four challenge**s will be present are:

- *Increase more cross-discipline collaboration among scientific staffs.*
- *Increase the faculty staff engagement to transfer more of their research to teaching.*
- *Increase the faculty staff collaboration with industry.*
- *Increase the understanding of the importance of teamwork among engineering students.*

Then, CBL facilitators will ask participants to organize themselves into teams according to the challenge that they are interested in.

Once this has been decided upon, participants can then proceed to the **Investigate** phase. Here, participants develop guiding questions to gain the knowledge needed to develop a solution to the challenge. Guiding questions continue to emerge throughout the challenge (Nichols et al., 2016). These could be gathering relevant data for their challenge. we also will present a problem-solving technique for this stage such as fish techniques. By these tool participants understand problems in a more holistic and in-depth way and enable them to structure their investigations. Participants then will develop their own guiding questions and resources to better understand their challenge. The learnings from this phase provides a foundation for the eventual identification of potential solutions to the challenge (Nichols et al., 2016).

In the **Act** phase we will present a technique to develop potential solutions. This includes the 'six thinking hats' technique which encourages each participant to take a different role for developing solutions and help choose the best solution. These roles can include thinking more innovatively, or more cautiously, in a more risk-averse manner or in a more bold and experimental way. This is a key part of CBL as it demonstrates how participants do not have fixed roles and are able to change their roles to have different perspectives on their challenges. Solutions should be evidence-based and implements with an 'authentic' (real-life) audience. They should evaluate the effectiveness of the solution and adjust which will deepen their subject area knowledge (Nichols et al., 2016). Within each of the phases there are opportunities for mini-investigation cycles and if necessary, a return to an earlier phase.

TARGET AUDIENCE

The workshop will be highly relevant for HE professionals who are interested in learning more about new pedagogical practices or have a basic knowledge of CBL but want to learn more about its implementation. No background knowledge or pre-workshop preparation is required. It will also be of interest to those with a particular interest in entrepreneurial education as it will demonstrate how CBL is an innovative pedagogy that can engender an entrepreneurial mindset in participants. Finally, it will also be relevant for educational policy makers and businesses that are interested in partnering with universities to mutually benefit from engaging participants with their area of expertise within a CBL project.
Workshop participants are advised to bring their own devices (labtop) for this workshop.

OUTCOMES

By the end of the workshop participants will have learnt about:

- The theoretical underpinnings of CBL and its three stages
- How to implement CBL in different educational contexts
- The benefits of CBL as an innovative pedagogical practice
- How CBL links to real-world issues and develops participants' professional

REFERENCES

Conde, M. Á., Rodríguez-Sedano, F. J., Fernández-Llamas, C., Gonçalves, J., Lima, J., & García-Peñalvo, F. J. (2021). Fostering STEAM through challenge-based learning, robotics, and physical devices: A systematic mapping literature review. Computer Applications in Engineering Education, 29(1), 46–65. https://doi.org/10.1002/cae.22354

Crawley, E., J. Malmqvist, S. Östlund, D. Brodeur, and K. Edström. 2014. Rethinking Engineering Education: The CDIO Approach. 2nd ed. New York: Springer Verlag.

Johnson, L., & Adams, S. (2011). Challenge Based Learning: The Report from the Implementation Project.

Membrillo-Hernández, J., de Jesús Ramírez-Cadena, M., Ramírez-Medrano, A., García-Castelán, R. M. G., & García-García, R. (2021). Implementation of the challenge-based learning approach in Academic Engineering Programs. International Journal on Interactive Design and Manufacturing (IJIDeM), 15(2–3), 287–298. https://doi.org/10.1007/s12008-021-00755-3

Nichols, M., Cator, K., & Torres, M. (2016). Challenge Based Learning Guide. Digital Promise.

Swiden, C. L. (2013). Effects Of Challenge Based Learning on Student Motivation and Achievement [Master Theis]. Montana State University.

Tang, A. C. Y., & Chow, M. C. M. (2020). To evaluate the effect of challenge-based learning on the approaches to learning of Chinese nursing students: A quasi-experimental study. Nurse Education Today, 85, 104293. https://doi.org/10.1016/j.nedt.2019.104293

BIOGRAPHICAL INFORMATION

Yihan Xing is a Professor of Mechanical Engineering and Subsea Technology at the University of Stavanger, Norway. He is a permanent faculty staff of the marine and offshore group at the Department of Mechanical and Structural Engineering and Material Sciences (IMBM) and the study program leader for M.Sc in Marine and Offshore Technology. Professor Xing teaches courses in subsea engineering, offshore field development and engineering mathematics. Professor Xing's research interests are modelling and analysing large complex machinery systems, including using AI-enabled and stochastic design methods, particularly within large subsea cargo drones and offshore wind turbines, where he is most active. In addition, he also works in other areas, such as subsea and agricultural robotics and wave energy converters. Xing has authored more than 100 technical publications and reports. He has served and is serving on the editorial boards of 14 international journals. Further, he has seven years of experience in the subsea industry in pipeline engineering and product development. Xing is a Singaporean and has been living in Norway since 2008.

Fiona O'Riordan is an Academic Developer, and part of this role include supporting academics implement CBL in Dublin City University. She has an Ed.D in Curriculum Development Discourse. Recently, Fiona has been seconded to ECIU (European Consortium of Innovative Universities) as CBL Portfolio Coordinator.

Masoumeh Shahverdi has Ph.D. in Social Entrepreneurship Education. She is CBL expert and implements and trains challenge-based learning in ECIU universities. Her academic training and her teaching and research experiences is in Challenge based-learning, Innovation Management & Organizational Technology, Business Plan, and Theories of Entrepreneurship Management, Entrepreneurship in New Technology, Social Entrepreneurship education, and Intellectual Properties. Masoumeh also is member of EEA & Norway Grants which provide

Guidelines and principles for challenge-based education and mission-oriented research approaches. And she also is member of BIE project which tries to integrate competences in sustainability, innovation, and entrepreneurship into the study programs across the faculties at UiS. She was work package lead in ECIU project. She has implemented CBL in many different educational settings including on bachelor's and master's programmes at the University of Stavanger and stand-alone extra-curricular CBL courses.

Timothy Marshall is a teaching assistant and CBL expert who has an MA in English Literature. He first became involved in CBL as a student himself before assisting Masoumeh on implementing CBL on different projects. Prior to moving to Norway he worked in various public policy roles in the UK including for the UK government and third-sector organisations.

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