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Developing a Maturity Model to support successful innovation in Higher Education.

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Abstract: If educational institutions want to be successful in future-proofing their education, an important factor is keeping the educational development aligned with the organizational development. This also includes alignment between the course, the program and the institutional level. How can we know whether organizational and educational development are in line on all three levels? In this paper, we discuss the use of a maturity model (MM) to get one step closer to answering that question. We present the case of introducing Challenge Based Learning as educational innovation in Higher Education Institutions (HEI) education. Based on a literature review of the key features of the Challenge-based learning we present the changes needed to the original e-Maturity Model developed by Marchall to fit that new purpose. We provide proof of concept of a MM based approach to the alignment of educational and organizational development, an approach which can be extended to other innovative practices.

Keywords: Challenge Based Learning, Maturity Model, Innovation, Higher Education

Introduction

At the University of Twente (UT), an increasing number of staff has been implementing Challenge-based learning (CBL) or features of CBL in their teaching. CBL is an educational approach which encourages 'active learning' just like Problem-based learning. The main difference with other active learning methods is that by having students learn by working on real life challenges instead of case studies, they could start making a difference right now by creating impact and thereby contribute to solving the problems that society faces (Clegg & Diller, 2019; Gallagher & Savage, 2020; Leijon et al., 2021).The concept of CBL is that learning is driven by challenges, open-ended, multiple solution, no single right answer problems. The outcome is not predictable; the process determines the direction. Therefore, the educators and students are both learners and teachers. Students enter the real world, involving all stakeholders and community members necessary in the process to mobilize resources. Furthermore, they must

publish the outcomes of each step to receive feedback and learn from mistakes (Clegg & Diller, 2019; Leijon et al., 2021). Besides being student-centered, CBL is above of all student-driven; educators do not dictate the learning activities at the outset nor the individual learning goals of students. Another important feature of CBL is collaboration. Although collaboration is also part of problem or project-based learning, in CLB collaboration takes place in an interdisciplinary way. Regarding the outcomes of CBL, the solution students come up with must be environmentally, socially and economically sustainable (*Education/Research Driven by Challenges*, n.d.; Loohuis & Chapel, 2021; Nicholls, 2018). In spite of rising interest and commitment in Higher Education (HE) institutions for innovating education to become future proof, it seems they find it hard to materialize innovations such as CBL across all levels (course, programme and institution) (Nowell et al., 2020; Serdyukov, 2017; Tassone et al., 2018).

Innovation of education

If educational institutions want to be successful in future-proofing their education, an important factor is keeping the educational development aligned with the organizational development. An alignment implies that the education provided in the organization is supported in such a way that education has the maximum impact. Maturity models are well-recognized instruments for systematically assessing the extent to which the organization and educational processes are in line with each other and for gaining insight into where improvement actions are both needed as well as possible within the organization.(Laer et al., n.d.; Marshall, 2010)

The UT chose challenge-based learning as a potential educational approach to support some of her ambitions (Loohuis & Chapel, 2019). Furthermore, CBL is identified as the educational approach in the ECIU-U and reflected in shaping 2030 (Shaping, 2018). The fact that CBL is still in its infancy could be seen as an attempt to encourage staff to be more involved in finding new innovative ways to become future proof as CBL provides a framework that encourages teachers to reflect on the concept of knowledge production and learning in higher education more in-depth to gain a better understanding (Leijon et al., 2021). Testing CBL in an experimental setting differs from a more strategic top-down choice for an educational approach. Bottom-up innovation is known for more slowly evolving, continuous discussion, development, and improvement while experimenting. However, innovative educational approaches do not lend themselves to a prolonged period of adapting. It needs to be scaled up quite quickly to clarify whether adoption or diffusion will occur (Fahey, 2012; Joos & Meijdam, 2019; Kamp, 2020; Tassone et al., 2018; van der Zwaan, 2017) Flexibilization and innovation of education put a strain on teachers. For this reason alone, teachers must be given the support required for this. When implementing the CBL approach in an existing module or course, the assessment policy, intended learning outcomes, and the available time are fixed factors. Like any other element of education, the success of CBL as an educational approach depends largely on the alignment with other aspects of the educational system surrounding it (McKenney, Nieveen, & van den Akker 2006). At this moment, there seems to be a missing link between the flexible and customizable framework CBL promises to be and the practical implementation of CBL. Innovation of a curriculum does not happen just because it is one of the strategic goals, and it requires openness and interaction between the actors involved. It cannot be expected that staff will start the challenging process of transformation towards a future proof curriculum on their own without proper support and resources (van den Akker et al., 2006). The processes needed to support education within a university are usually obvious. However, to systematize and align these processes at the different levels of the institution can be quite a challenge (S. Marshall, 2010; Tocto-Cano et al., 2019.)

A Maturity Model for introducing CBL

A Maturity Model is designed to help educational institutions improve their ability to innovate successfully. The e-learning Maturity Model (eMM) of Marshall (2010) was chosen as the basis for the development of a challenge-based learning maturity model (CBL-MM). Marshal (2010) mentions several potential benefits for using educational Maturity models; (1) providing a roadmap for implementing and improving e-learning in ongoing education, (2) measuring the current innovation capability and identifying and prioritize the processes to improve, (3) enhance inter- and intra-institutional collaboration, by offering insight in the strengths of each level as well as providing a framework for a quality standard for collaboration between universities, and (4) the model gives the opportunity to keep the discussion about quality education going. The Maturity Model does not differentiate between courses, programmes and institutions and instead of seeing strength and weakness as opposites, it recognizes that there are things to be learnt from both.

The model focuses on the collection and sharing of effective teaching practices, so it can be used to guide the further development of innovative teaching practices (Marshall, 2010).

As categories and related processes in the e-MM have already been validated for higher education, the reference of the categories and the specifics of the processes (Marshall calls them practices), had to be tweaked to

refer to categories and the practices relevant in challenge-based learning. This leads to the following five categories which can be identified in every HEI:

1. Learning: all processes that directly impact pedagogical aspects of Challenge-based learning,
2. Development: all processes surrounding the creation and maintenance of Challenge-based resources,
3. Support: all processes surrounding the support and operational management of Challenge-based learning,
4. Evaluation: all processes surrounding the evaluation and quality control of Challenge-based learning through its entire lifecycle,
5. Organization: all processes associated with institutional planning and management

Processes define an aspect of the overall ability of institutions to perform well in the given process area and thus in innovating education overall. The advantage of breaking down complex areas of educational processes into related segments that can be assessed independently is that it can be used at all levels in an organization and by staff in any role. This means that it can be used to improve the quality of educational processes on an almost individual level.

The model focuses on the quality of processes that are essential for success, which can be reproduced and extended as needed. This Maturity Model describes the capability of a process from the synergistic perspectives of five dimensions: Delivery, Planning, Definition, Management and Optimization. (Laer et al., 2017). A high score on one dimension suggests that this can be seen as a strength while a lower score indicates that this is potentially an area for improvement. Each dimension is broken down into different practices that define how the process outcomes can be achieved by institutions. The practice statements attempt to measure activities that can be directly observed for each process and dimension. The practices are

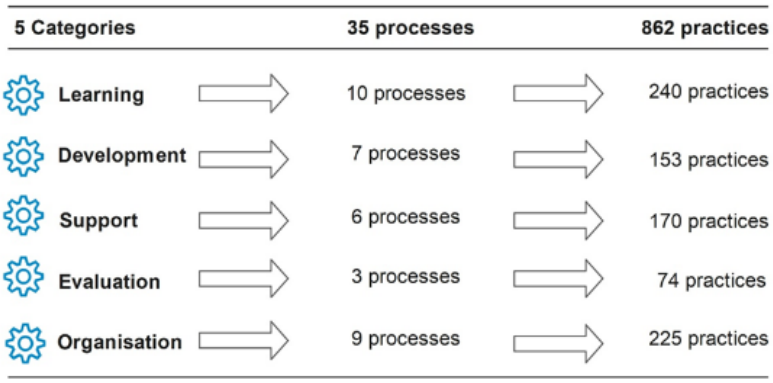

Figure 1. Categories, processes and practices based on the eMM (Marshall, 2006)

based on scientific evidence of their importance for educational quality. There are four answer options per practice statement: Not adequate, partially adequate, largely adequate and fully adequate. All scores are weighted per process, and the result of this weighting becomes visible in the datasheet shown in Figure 2.

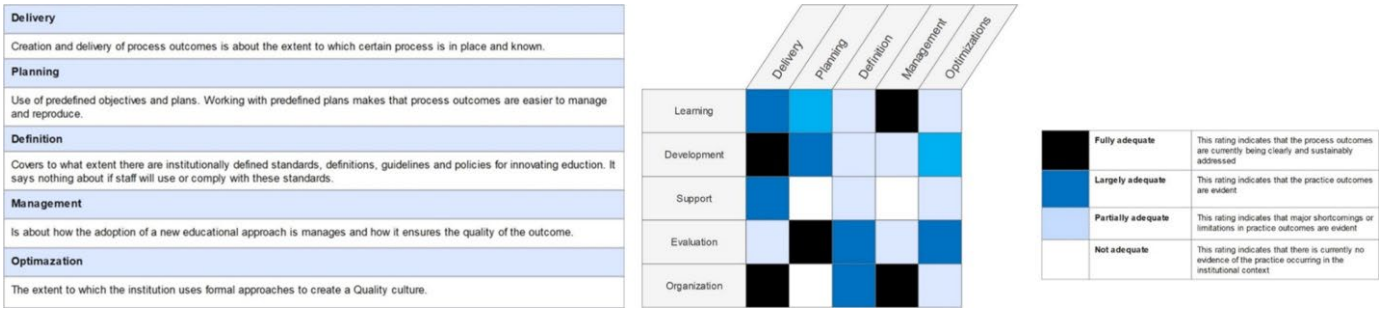

Figure 2. Categories and dimensions from the eMM (Marshall, 2006)

Challenge-based learning: framework and key features

Challenge Based Learning is a multidimensional, flexible and customizable framework, that is much more than the mere sum of its identifiable characteristics and key elements. It is an evolving model, with complex relationships among its elements, and is conceptualized as follows by Nichols, Cator and Torres (2016, p.7):

> "1. A flexible and customizable framework that can be implemented as a guiding pedagogy or integrated with other progressive approaches to learning. 2. A scalable model with multiple points of entry and the ability to start small and build big, 3. A free and open system with no proprietary ideas, products or subscriptions. 4. A process that places all learners in charge, and responsible for the learning. 5. An

authentic environment for meeting academic standards and making deeper connections with content. 6. A focus on global ideas, meaningful challenges and the development of local and age-appropriate solutions 7. An authentic relationship between academic disciplines and real-world experience 8. A framework to develop 21st-century skills 9. Purposeful use of technology for researching, analyzing, organizing, collaborating, networking, communicating, publishing and reflecting. 10. The opportunity for learners to make a difference now. 11. A way to document and assess both the learning process and products, 12. An environment for deep reflection on teaching and learning."

Introducing CBL is different from introducing e-learning at a HEI. While it is clear that maintaining the overall structure of the MM is essential, the specifics of the processes and indicative practices will need to be adapted to the specifics of the innovation. Thus, it is important to focus the question on CBL specific characteristics that are considered most important in HE.

A systematic review of Challenge-based learning formats used in higher education was conducted in May 2021 by exploring major scholarly databases in educational research: Web of Science, EBSCO, Scopus. The term "challenge-based learning" was searched for in the article title, abstract and keywords; the other inclusion criteria were peer-reviewed papers and journal articles published between 2008 – 2021, English language, and Higher education. The initial set of 376 papers was brought back to 196 by screening the titles and keywords. The exclusion criteria were "problem-based" and "literature reviews". After removing duplicates, 133 articles remained, of which the abstracts were subsequently screened. The total number of studied papers and articles was 26. The remaining articles were uploaded in ATLAS.ti and coded for core characteristics. We found five key features of CBL that were cited in all papers: real-world challenges, interdisciplinary collaboration, competence development, self-directed learning and stakeholder involvement.

Besides the literature review, we conducted five interviews with educators, support staff and management of the University of Twente from September 2021 until February 2022.

1. real-world challenges

Challenges should be real urgent societal relevant problems, that are so complex and unpredictable that no single solution can ever be the best one nor do we know if the solution will have the right effect based on the available data. In education, however, challenges are typically conveyed as stand-alone problems while in fact they consist of multiple interlocking problems. Working on a solution means that the entire context of the challenge must be mapped out, i.e., both the individual problems and the cluster as a whole (Jonassen, 2000; Najarian & Vasilache, 2012).

2. interdisciplinary collaboration

To cope with the demands of the industry in the future, the simple transfer of knowledge is not sufficient, since knowledge by itself does not offer solutions to environmental, social, technological, ethical and economic challenges. This implies that career paths will likely become more non-linear, and the pursuit of knowledge becomes more interdisciplinary; thus, students must continuously refresh their knowledge and apply it to new contexts (Nicholls, 2018). In order to learn from other disciplines or to be able to adopt and apply tools from other disciplines into their own field of study, students require a solid discipline-specific knowledge base. In addition, students should be equipped with the competencies and skills needed for interdisciplinary collaboration.

3. competence development

Rather than designing courses solely around content, CBL organises learning also around the development of essential skills. The goal is not to stop thinking about content but to modify the current design method, decisions about what content to teach and how much should be offered by educators, students and stakeholders with a focus on core skills and intended learning outcomes. In this way, not only the educator but also the student knows why the content learned is relevant.

4. self-directed learning

CBL is an approach whereby students are involved in their learning, formulate questions, investigate widely in cooperation with different stakeholders and disciplines, and then build new understandings, meanings and knowledge. The advantage of allowing students to co-design their own learning process is that they can individually build on prior knowledge and experience, which allows them to learn more effectively throughout the process. In addition, students will be much more motivated when they have found out for themselves what knowledge and skills they need (Hamilton et al., 2005; Fletcher, 2006).

5. stakeholder involvement

In recent years, higher education invested in increasingly involving stakeholders in the learning process, for example, as a guest speaker or problem owner in projects. Whereas it is the very essence of the CBL approach that students learn to think critically, they need to deeply understand the problem and the circumstances in which the problem exists. It has been shown that problems are processed more efficiently and are remembered better by first starting with a helicopter view and then homing in on specific details (Berland et al., 2013; Nichols & Cator, 2008). When students are not afforded to start their exploration in a top-down way but rather somewhere in the middle, they have no choice but to focus on the details, which is exactly the opposite of what CBL is all about. Therefore, in CBL students start at the same point as the main stakeholder. Note that stakeholders also include all people who are either currently affected by the 'problem' or who will benefit from or be negatively affected by the possible solution. Students should be encouraged to engage with as many stakeholders as possible when working on a challenge. Students are also expected to think about and work on a solution as full-fledged partners, to assure they are involved from the start and can follow the thought processes towards a solution. This means, among other things, they should also have full access to relevant information from stakeholders.

Building the CBL-MM

Building on the original and validated Maturity Model (Marshall & Mitchell, 2003; 2004), while maintaining its original structure, we proceeded to add the specifics of CBL in the description of processes and practices as gathered from our literature review on CBL as well as the interviews presented in the previous section.

Like the original version of the eMM, the CBL-MM divides supporting innovation in education into five main categories: learning (L), development (D), support (S), evaluation (E) and organisation (O). These categories contain 35 processes (L1-10, D1-7, S1-6, E1-3, and O1-9) that are necessary to successfully innovate education (Figure 3). In turn the CBL framework as well as the 5 key features identified during our meta-analysis of the literature are added to the framework. Check marks in the first column of Figure 3 (CBL Framework/Design) represent which of the five main categories and 35 processes incorporate the complex and interactive nature of challenge-based learning, thereby representing the fact that challenge-based learning cannot be reduced to a simple adherence of a set of principles. The remainder of the check marks reflect where in the CBL-MM the five key features of CBL are present.

We then explored each of the 35 processes and more than 500 related practices from the perspective of the CBL framework/design and the 5 key features of CLB as derived from our literature review and interviews: real-world challenges, interdisciplinary collaboration, competence development, self-directed learning and stakeholder involvement. Below we provide a few examples of how these aspects of CBL are present in our CBL-MM.

1. real-world challenges,

This aspect of CBL is present in *O4. Working on real life challenges is guided by an institutional integrity plan*. Teaching staff are provided with resources (including training, guidelines and examples) on intellectual property law and licenses.

2. interdisciplinary collaboration,

This aspect is present at the teacher/course level in *S1. Students are provided with learning support* (interdisciplinary learning, self-directed learning...)

3. competence development,

We find this in *L8. Assessment is designed to progressively build student competence and is designed to measure both the learning process as well as the end result*.

4. self-directed learning

We find this at the teacher level in *L10. Courses are designed to support personalized learning.* CBL design and (re)development procedures require the use of a variety of personalised learning activities and resources. Hence, staff engaged in CBL design and (re) are provided with a researched evidence base of personalised learning issues and requirements.

5. stakeholder involvement.

This aspect is present in *S2. Students are provided with real world (open) data and information facilities when engaging in CBL.* Support staff are provided with support resources (including training, guidelines and examples) for assisting students when working with open data

		CBL framework/design	Real-world Challenges	Interdisciplinarity	Competence Dev. 21st century skills	Self-Directed Learning Flexible learning	Stakeholder Involvement
Learning: Processes that directly impact on pedagogical aspects of CBL							
L1	Learning objectives guide the design and implementation of CBL courses	✓					
L2	Students are provided with mechanisms for interaction with all stakeholders involved						✓
L3	Students are provided with CBL skill development				✓	✓	
L4	Students are provided with expected (staff) response times to student communications						✓
L5	Students receive feedback on their performance within CBL courses				✓	✓	
L6	Students are provided with support in developing research skills needed for working with real-world open data		✓		✓		
L7	Learning designs and activities actively engage students		✓				
L8	Assessment is designed to progressively build student competence				✓	✓	
L9	Student work is subject to learning-driven timetables and deadlines					✓	
L10	Courses are designed to support personalised learning					✓	
Development: Processes surrounding the creation and maintenance of CBL resources							
D1	Teaching staff are provided with design and development support when engaging in CBL	✓					
D2	Course development, design and deliverance guided by CBL procedures and standards	✓					
D3	An explicit plan links CBL pedagogy, skill development and content used in courses				✓		
D4	Courses are designed to support disabled students		✓				
D5	All elements of the physical CBL infrastructure are reliable, robust and sufficient		✓				✓
D6	All elements of the physical CBl infrastructure are integrated using defined standards	✓					
D7	CBL resources designed by students and teaching staff are designed and managed to maximise reuse		✓		✓		✓
Support: Processes surrounding the support and operational management of CBL							
S1	Students are provided with learning support (e.g., interdisciplinary learning, self-directed learning) when engaging in CBL			✓		✓	
S2	Students are provided with real world (open) data and information facilities when engaging in CBL		✓		✓		✓
S3	Student enquiries, questions and complaints are collected and managed formally	✓					
S4	Students are provided with personal and learning support services when engaging in CBL					✓	
S5	Teaching staff are provided with CBL pedagogical support and professional development	✓					
S6	Teaching staff are provided with support in finding challenges and real-world environments for students		✓				
Evaluation: Processes surrounding the evaluation and quality control of CBL through its entire lifecycle							
E1	Students are able to provide regular feedback on the quality and effectiveness of their CBL experience	✓					
E2	Teaching staff are able to provide regular feedback on quality and effectiveness of their CBL experience	✓					
E3	Regular reviews of the CBL aspects of courses are conducted	✓					
Organisation: Processes associated with institutional planning and management							
O1	Formal criteria guide the allocation of resources for CBL design, development and delivery	✓					
O2	Institutional learning and teaching policy and strategy explicitly address CBL	✓					
O3	Challenge decisions are guided by an explicit plan		✓				✓
O4	Working on real life challenges is guided by an institutional information integrity plan		✓				
O5	CBL initiatives are guided by explicit development plans	✓					
O6	Students are provided with information on learning through challenges prior to starting courses				✓	✓	
O7	Students are provided with information on the challenges prior to starting courses		✓				✓
O8	Students are provided with administration information prior to starting courses	✓					
O9	CBL intiatives are guided by institutional strategies and operational plans	✓					

Figure 3 Overview of the 5 categories and associated processes incorporating the CBL framework/design (Nichols, Cator and Torres, 2016) and the 5 key features identified in our meta-analysis.

Conclusion

Maturity models that can support staff in the process of improving innovation in education are very valuable. However, Maturity Models for innovative educational approaches are scarce. The present paper reports the current state of the development of a CBL maturity model for HEI. This maturity model is being developed to address the complexity of innovation in HEIs and offer a useful tool for the demanding role of staff and management when future-proofing education. Additionally, this model is being developed respecting the original eMM (Marshall,

2010) to guarantee its recognition, solidity and relevance in the academic world. Our work is now at that third step of the project: validating the tweaked model. At this stage of Development, we are adopting a multicase study to interview a diverse group of teaching staff, policymakers, managers and support staff from the twelve partner universities of the ECIU. In this paper, we present the adjustments of the original model based on a literature review of the key features of the Challenge-based learning approach. The results of this research work have been both encouraging and promising amongst the first interviewed experts, revealing positive expectations about its usefulness in the future. Future analyses would include how the 35 processes are subdivided into practices (Figure 1) related to delivery, planning, definition, management, and optimization. The processes of the CBL-MM are interconnected mainly because different levels within the institution share ownership of the process or practice. These aspects can be found at the teacher, course and institutional level.

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