ORGANISING EVIDENCE-INFORMED INNOVATION: THE DEVELOPMENT OF A RESEARCH AGENDA

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ABSTRACT

Educational innovation often builds on existing practices, and focuses on improvement, rather than a radical change. One current example of educational innovation is Challenge-Based Learning (CBL). At university [blinded] the approach is a curriculum wide implementation of CBL based on a integrated programme that combines implementation of bottom-up innovation projects with research. The result of this research contributes to the translation of CBL to practice, thus helping curriculum designers and teachers in designing and executing their courses. In the process evidence is collected about principles of CBL, learning behaviour, learning outcomes, and didactical aspects of CBL, such as coaching and self-directed

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learning, assessment, pedagogies, and design of challenges, and facilitating structures.

The goal of this paper is to explore the development of a research agenda, which aligns research and practice, and to contribute to evidence for successful CBL implementation as result. The CBL research agenda shows which topics and aspects of CBL are addressed by research and practice, and which are overlooked. It is a systematic way of collecting strategic and practical problems related to CBL implementation, and how these are translated into research questions, methods, and results. The CBL research agenda leads to dialogue, which in turn guides our CBL programme. This integrated programme, including the research agenda is governed by a Taskforce CBL and supported by programme management, and a university wide research community. This approach enables the curriculum wide implementation and research of CBL as a concept for educating engineers of the future and strengthening on-campus education.

1 INNOVATION IN HIGHER EDUCATION

1.1 Challenge-Based Learning as a case of innovation

Educational innovation often builds on existing practices, and focuses on improvement and renewal, rather than a radical change. One current example of educational innovation is Challenge-Based Learning (CBL) [1]. In CBL challenges are seen as self-directed work scenarios in which students engage [2]. For CBL the objective is to learn how to define and address the problem and to learn what it takes to work towards a solution, rather than to solve the problem itself. The final deliverable can be tangible or a proposal for a solution to the challenge [3]. Central to CBL is that students develop knowledge, skills, and attitude by engaging in real-life challenges, often in interdisciplinary teams.

CBL as a concept allows for flexibility in and experimenting with effective teaching and learning activities, rather than predefining them. The aim of these experiments is to translate CBL as an educational concept to practice, thus helping curriculum designers or teachers in developing their courses and teaching, and in formulating support requirements.

1.2 Curriculum wide implementation of CBL

If universities intend to use CBL as a concept for innovating the curriculum, a developmental perspective is needed, which implies a variety in CBL characteristics across study components, i.e. courses and projects. This developmental perspective helps to align initiatives and bring a sense of coherence to the discussion, rather than anchor and confine research and practice. The result is a flexible approach in what are considered challenges suitable for CBL.

At a university of technology in the Netherlands, the approach is a curriculum wide implementation of CBL based on an integrated programme that combines bottom-up innovation projects with research. This combination leads to evidence about what works in the context of this university, which in turn informs educational design and practice. This approach fits the university's ambition to move towards CBL as a concept for educating engineers of the future and strengthening on-campus education. Implementation of CBL in the university's educational program, allows for a further integration of supporting students to develop knowledge, skills, and attitude, which already was part of the Bachelor's curriculum.

The integrated CBL programme allows for experiments in which teachers explore ways to make their study components more CBL. With an evidence-informed set-up the effects on student learning behaviour of these bottom-up experiments are carefully studied, answering questions about didactical aspects, such as coaching and self-directed learning, assessment, pedagogies, and design of challenges. In addition, staff engages in a range of research projects bridging the concept of CBL and everyday educational practice. The findings of this programme thus guide the design of CBL.The large-scale curriculum approach, in combination with research contributes to the current limited body of evidence for mechanisms that cause CBL interventions to be effective.

Facilitating bottom-up innovation projects implies allowing that teachers can have their own interpretation, which translates the educational concept CBL to educational practice. Furthermore, because educational practice aims to stimulate and facilitate student development, the need arises to allow for different forms of challenges. Hence, a working definition and conceptualisation was applied that supported the developmental perspective and the bottom-up innovation projects [4]. However, to stay in touch with and build on current research in the field, the aim was a definition and conceptualisation that both included commonalities emerging from CBL literature, and that allowed for variety in CBL characteristics between study components or curricula. The resulting framework thus serves as a methodological approach to make engineering education (more) CBL [4].

The framework consists of the higher order concepts vision, teaching and learning, and support, each with subsequent dimensions and indicators that describe CBL in a fine granulated way (please see [4] for a detailed description). These dimensions and indicators together form the basis for an educational view on CBL.

1.3 Organising the curriculum wide implementation

The main body governing the CBL programme, is the taskforce CBL. This taskforce consists of scientific staff, educational programme directors, support staff, and students. The Taskforce CBL will in 2024 advice the University Executive Board on CBL in the university's education. All local research on CBL supplies input for this advice; the university allows itself the coming years to experiment with new initiatives before implementing the initiative at full scale. The aim is to learn how CBL should be shaped to optimize student learning in terms of for instance required fundamental knowledge/skills or combining a deep understanding and a broader view, and what changes are needed to vision, teaching and learning, and support [5]. Furthermore, all researchers involved in CBL at our university grouped themselves in a community of practice [6], with regular meetings to develop and share knowledge.

The variety of research questions on CBL called for a research agenda on student learning behaviour and outcomes, and didactical/pedagogical aspects of CBL with the purpose to:

- make the CBL implementation evidence-informed,
- make the implementation and research projects provide new evidence, which feeds iteratively in the implementation,
- bring together/align all CBL research and projects,
- give direction and guidance to this research and projects,
- support scale and scalability of CLB as a unique selling point.

The aim is a research-based grounding for developing CBL in engineering education. This grounding answers for the university context the basic "what works and why"-question, which in turn would allow teachers and educational leadership to take the next step towards a more systematic less diffuse approach to CBL [7].

The CBL research agenda as part of the CBL programme is the guiding document for research on principles of CBL (vision), student learning behaviour and learning outcomes, didactical/pedagogical aspects of CBL (teaching and learning), and facilitating structures (support). The findings of CBL research form a foundation for evidence informed development of the CBL experiments.

The remainder of this paper explores the development of a research agenda. This agenda aligns research and practice, and contributes to evidence for successful CBL implementation as result. Although the context is a curriculum wide CBL implementation, we believe that the research agenda can be used for a range of evidence informed innovations in higher education.

2 BUILDING A RESEARCH AGENDA

2.1 What is a research agenda?

In general terms a research agenda shows which themes and aspects of a specific topic are addressed by research and practice, and which are overlooked. It is a systematic way of collecting strategic and practical problems related to educational innovation, and how these are translated into research questions, methods, and results. It allows individual experiments and research projects to focus on issues and ideas in a subset of the topic. Yet, it offers an overview of all issues addressed by research. A research agenda is not set in concrete; it naturally changes over time as knowledge grows, practice evolves, and as new research questions emerge.

The research agenda on a larger scale thus guides the governing body - in our case the CBL taskforce - throughout all parallel research processes. Because of the overview, it can also serve as a concept note to advisors and stakeholders including university deans, department deans, teacher education, policy advisors, and teachers, while guiding possible new research proposals.

2.2 How to design a research agenda?

Existing literature gives little starting points for designing a research agenda on a curriculum scale. Especially in nascent fields such as CBL, conceptualisations have not yet been set, and by result relevant themes go in many directions and are only emerging [8]. Our first approach was to follow the lines of a common research plan and report:

- What is the practical/strategical problem to be addressed?
- What is the research area: short problem definition, and possibly description of context (e.g., courses, department)?
- Need to know: research question to be answered, what lack of knowlege can be identified?
- Need to do: research method/approach
- Need to do: what knowledge needs to be implemented? Is additional research needed?
- Need to do: sustainability, dissemination. How to make research less person-dependent. How to add to the researcher community.

Of course, these questions can be extended with organisational aspects:

- Which project addresses this problem?
- Who is involved?
- What is the project's timeframe?

The next step was to answer all these questions for each bottom-up experiment and research project. The result is a matrix with in the columns these questions, and each project filling a row (see also Table 1 for an example). Although this matrix gives a clear overview of projects and how these address practical or strategical problems, it is not yet related to aspects of the innovation topic, in our case CBL.

Table 1. Margins of the page size A4 [mm]

Practical/ strategical problem	**Research area/ problem definition**	**Need to know: research question**	**Need to do: research method**	**Need to do: knowledge to be implemented**	**Need to do: dissemination**	**Project**
Effective teaching	Coaching/assessment	What are effective combinations of coaching/supervision and assessment?	Survey, interview	Starting points for redesign/ design principles	SEFI paper, 4TU innovation map, presentations	Preparing engineering students for the future
How to design effective pedagogies for learning from challenges?	How to structure the process of learning from challenges?	What are effective pedagogical approaches to help students learn from challenges?	Interview, portfolios			CBL pedagogy; Interuniversity
How to integrate disciplinary knowledge and skills acquisition in CBL	1a. - In prior learning and just-time-learning; 1b. - In formative and summative assessment		Interview, observations, course materials		Conference paper, presentations, article, teacher sessions	Modularisation

2.3 The CBL research agenda

To increase our understanding of which project addresses what CBL aspect, the fine granulated CBL conceptualisation presented by [4] was added to the matrix: each dimension and indicator of that framework was placed on a row in the matrix. Next, all experiments and research projects were re-ordered and grouped with the

dimensions and indicators. The result is a theory driven overview of all experiments and projects.

Because the input for the matrix came from both researchers and teachers, and from the taskforce CBL, the overview also made clear which practical and strategical problems were considered relevant, but were not yet addressed by any experiment or research project. The research agenda thus serves as a steering instrument for new experiments and research proposals.

3 CONCLUSION

Initial goals for a research agenda can be defined as:

- Themes: Identify guiding themes and setting research questions, crucial for identifying current and future experiments and research,
- Informed decision making: Prioritizing themes with stakeholders (i.e. taskforce, university deans, department deans, teacher education, policy advisors, and teachers),
- Evaluate experiments: Develop a QA system to secure delivering evidence,
- Research community: Build a research community and ensure dissemination,
- Level up experiments: The experiments in the first stage are mainly done on course-level. The timeline for the research agenda also suggest the next phase, once we have had ample time to learn from these experiment.

Each goal consists of multiple actions to reach that goal. Urgency of goals and actions need to be aligned with the CBL programme plan. Furthermore, it is important to tap into existing knowledge and experience from research and experience at our university.

The main outcome of the research agenda is to support the taskforce CBL and the CBL programme in their planning and decision making. The agenda defines the playing field for research resulting in evidence for grounding educational developments. This requires a typology of challenges, including context, which in turn supports developing a shared language among stakeholders, and allows for a local flavour of CBL.

Currently the research agenda shows preliminary results of ongoing projects. Next step is a more elaborate overview of final results. However, even with only preliminary results, the agenda makes clear where the gaps are, which gives starting points to guide research towards those topics.

The strength of a research agenda, as may be clear from this exploration, is an overview of all university wide initiatives on CBL. This informs policy makers, education designers, and researchers alike. The weakness of a research agenda is the effort required to build and maintain it. Furthermore, it requires a culture of sharing and trust: teachers need to be open about the progress and outcomes of their bottom-up innovations, researchers need to be willing to share already at early stages of their project. In our case, the research community helped to overcome this possible weakness.

The main opportunity for a research agenda based on a research plan combined with a theory driven educational view, is that the similar approach can be used on different topics to make innovation truly evidence-informed.

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