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Challenge based learning in higher education– A systematic literature review

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ABSTRACT

This review maps patterns in research on Challenge Based Learning (CBL) in higher education (HE) between 2009 and 2020. How is CBL defined in HE settings? How is CBL in HE grounded scientifically in the research? The results show a shift of CBL from being a concept coined by a multinational technology company targeting learning in schools, to being embraced by HE, first and foremost as a method for transformation of adult learning. A critical scientifically grounded approach towards learning is however absent or marginally present in the papers reviewed.

KEYWORDS

Challenge-based learning;
higher education; theories;
adult learning

Introduction

Higher education institutions (HEIs) as providers of knowledge are closely interconnected with societal challenges and the transformation to a sustainable society. One learning approach in HEIs – often described as “challenge based” – is to manage how to put theory to the test in addressing real problems in collaboration with actors of society. In 2008, the concept Challenge Based Learning was coined by the technology company Apple and proposed as a solution for the school system to meet the needs of the 21st Century workplace:

Challenge Based Learning is an engaging multidisciplinary approach to teaching and learning that encourages students to leverage the technology they use in their daily lives to solve real-world problems. Challenge Based Learning is collaborative and hands-on, asking students to work with peers, teachers, and experts in their communities and around the world to ask good questions, develop deeper subject area knowledge, accept and solve challenges, take action, and share their experience (Nichols & Cator, 2008, p. 1)

Today CBL has moved into the HE sector (Johnson & Brown, 2011). In a guide from 2016, Nichols et al., include higher education when they state that ‘Challenge Based Learning is an effective learning framework initiated at Apple, Inc. and used in universities, schools, and institutions around the world.’ (Nichols et al. 2016, p.4).

CBL draws from different educational theories, and pedagogical methods, for example, problem-based learning (PBL) and inquiry-based learning (IBL). PBL has been widely adopted in for example, medicine and engineering education, much because of the

expected benefits in improving students' critical thinking, self-directed learning, generic skills, and long-term retention (Lund & Jensen, 2020; Strobel & Van Barneveld, 2009). IBL is defined in different ways in the literature and associated with a range of educational goals, but Aditomo et al. (2013) state that the concept at least entails question and problem-driven student projects with a focus on knowledge creation. IBL can be effective in enhancing students' ability to inquire, research, and solve problems but can also be perceived as a process of risk-taking and thus result in lower degrees of satisfaction in student evaluations (Archer-Kuhn & MacKinnon, 2020).

Furthermore, CBL connects to entrepreneurial learning as well as self-regulated learning, organisational double-loop learning, and authentic learning. To sum up, we can trace theories of learning stemming from cognitive, but also constructive and socio-cultural perspectives where learning is active, relational, practical, and situated within both the individual and the organisation (Argyris & Schön, 1978; Kolb, 1984; Lave & Wenger, 1991). One could argue that CBL picks central concepts from a range of theoretical perspectives in a way that meets 21st-century challenges. However, neither in the initial Apple paper nor in the guideline from 2016, the framework is explicitly theoretically grounded. Consequently, the aim of this review is to map research on Challenge-Based Learning in HE between 2009 and 2020 with focus on the following research questions: What research has been published? How is CBL defined in HE settings in relation to the definition by Apple? How is CBL in HE grounded scientifically in the research?

Method

A combination of quantitative literature review (SQLR) method with qualitative thematic content analysis is used to answer the research questions. The methods can provide both breadth and depth in our exploration of the growing field of CBL. The systematic quantitative literature review offers a way to identify not only what is known in a field, but also gaps (Pickering & Byrne, 2014). Qualitative analysis is appropriate when mapping a concept like CBL over time and as a thematic way to analyse findings in the material (Braun & Clarke, 2006). Peer-reviewed journal articles and conference papers were targeted, and based on our own language skills, the search was limited to papers in English. The time frame was 2009–2020, and papers using “challenge based” in higher education/university were included. To secure a broad database search, ‘challenge based’ was also combined with learning, education, instruction, or teaching.

Search strategies

Libsearch, a meta-database including Ebsco, Eric, ERC, Pro quest, Cinahl 125, Medline, Scopus, and Phsysinfo, was used. 307 abstracts were identified and with duplicates removed, 221 papers remained. A second search for validation resulted in no new articles, thus all included papers were exported to an online screening programme and two researchers conducted a double-blind review based on criteria of inclusion,

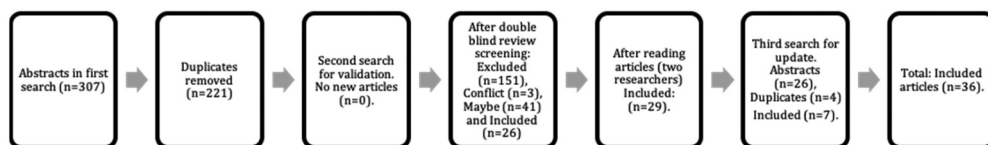


Figure 1. Illustration of the search and screening process.

with the result of 29 remaining papers. A final search, to ascertain the inclusion of recently published research (2019–2020), resulted in 7 seven additional articles (total $n = 36$) see Figure 1.

Analysis

A systematic quantitative literature review (SQLR) method was used to map research on CBL in HE (Pickering & Byrne, 2014). A content analysis, where the material was represented in the form of frequency and main categories (Bengtsson, 2016; Krippendorff, 2004) was made. Two researchers independently mapped the material and read through the articles in search of the application of ‘Challenge Based Learning’ or concepts related to ‘Challenge based’. The definition statements were compared to keywords stemming from the Apple definition by all four researchers. To answer how CBL in HE is grounded scientifically, an inductive thematic content analysis was conducted, where coding and patterns were directed by the content of the data (Bengtsson, 2016; Braun & Clarke, 2006). To reduce the risk for researcher bias, one researcher did an independent analysis of the material, then another researcher reviewed the themes in relation to Patton’s (1990) dual criteria for judging categories – internal homogeneity and external heterogeneity, to make sure that the themes should cohere together meaningfully and there should be distinctions between themes; this included a revision of the naming of themes.

Results

What research has been published?

This result mirrors a growing research field involving different disciplines with engineering as the most prominent. Most publications are from Spain and the USA, followed by Mexico and Sweden. In 2018, there was a significant increase in the number of publications addressing CBL and a broader geographical spread. Nine papers are published in journals with an educational profile, thus a major part of the articles have been published in disciplinary journals, see Table 1.

Table 1. The table illustrates when the papers were published, the geographical origins and the represented disciplines.

When	Where	Discipline
2009 (n1)	USA	Engineering
2012 (n2)	USA 2	Engineering Design
2013 (n4)	United Arab Emirates Spain/Mexico Spain 2	English Engineering 3
2015 (n4)	Austria/Poland/France Sweden Spain Thailand	Engineering 2 International business school Information management
2016 (n3)	Hong-Kong Sweden Spain	Engineering Engineering/Computer science Nursing
2017 (n2)	Spain China	Engineering 2
2018 (n11)	USA 2 Brazil 2 Mexico Indonesia Sweden Poland/Lithuania Switzerland/Norway Australia Chile	Engineering 6 Engineering/Computer science Social work education Environmental health Communication Business education
2019 (n8)	Mexico 3 USA/England Italy Spain Sweden/Tanzania Sweden	Engineering 6 Entrepreneurship education Medicine
2020 (n1)	Hong-Kong	Nursing
Total (n36)	Most frequent country: Spain (n6), USA (n6)	Most frequent discipline: Engineering (n24)

How is challenge-based learning defined?

Eleven keywords were identified in the Apple-definition:

Challenge Based Learning is an engaging **multidisciplinary** approach to **teaching and learning** that encourages students to leverage the **technology** they use in their daily lives to solve **real-world problems**. Challenge Based Learning is **collaborative** and hands-on, asking students to work with peers, teachers, and experts in their **communities** and around the world to **ask** good questions, develop deeper **subject area knowledge**, accept and **solve challenges, take action**, and **share** their experience (Nichols & Cator, 2008, p. 1)

The keywords mostly used in the publications where teaching and learning (32 publications), solve challenges (30), real-world problems (27), collaborative (25), and ask questions (22). This is probably due to the strong focus on education and learning through solving challenges or problems. The low use of to take action and to share (15 and 13) may be connected to the low use of community, i.e. solution of a problem is not expressed as being shared. No fluctuations are identified within the time span (2009–2018) with

regards to the use of keywords in the publications, but 2019–2020 a majority of the papers use all keywords. 22 publications use the concept ‘Challenge Based Learning’, however, ‘Challenge based’ is also combined instruction, entrepreneurship, design, learning, and education.

How is CBL in HE grounded scientifically?

The following themes were identified: Frame; Frame and discussion; Frame, discussion, and combined analytic models; Frame, discussion, and other analytic models. Below, we will present some examples from the material, see [Table 2](#).

Table 2. In the first theme CBL is used as background or frame for educational interventions; in the second CBL is also discussed in relation to the results of the intervention; in the third theme CBL in addition to the first two aspects is used as an analytic model together with other theories, and in the fourth theme other theoretical perspectives are used as models for analysis.

Theme	Frame	Frame and discussion	Frame, discussion, and combined analytic models	Frame, discussion, and other analytic models
n (total n36)	22	3	8	3

Frame

The most frequent way to use the theoretical base of CBL is as background or frame for educational interventions ($n = 22$).

A typical example is a re-design of a course and as a method for teaching and learning. Some examples make use of the Apple paper, while others relate to the multidisciplinary approach of CBL and/or presents the theoretical roots of CBL, like problem-based learning (Luis & Marrero, 2013) or inquiry-based learning. Like in Santos et al. (2018): Active learning techniques, such as Problem-Based Learning, Project-Based Learning (PBL) and Challenge-Based Learning (CBL) engage students and improve their performance positively. This type of technique moves students beyond a watchful role in traditional classes to activities that engage students in real problems (p. 155).

Another example is Fiore et al. (2019) who pinpoint the need for a multidisciplinary environment while teaching challenge-based entrepreneurship and connects to design-thinking. In the theme, CBL is presented on a descriptive level as first and foremost an educational method used to change a learning environment towards an active, authentic and problem-based learning process.

Frame and discussion

The articles in the theme ($n = 3$) depicts CBL as a background or frame discussed in relation to the results of the intervention, like in this example where CBL is discussed as an educational strategy in a nursing program: The results indicate that CBL may facilitate deep learning in nursing students/ . . . /Nurse educators should consider students’ study burden when adopting CBL in the nursing curriculum and be aware of students’ capacity for self-directed learning (Tang & Chow, 2020, p. 6).

Malmqvist et al. (2015) discuss how CBL can pose new demands on faculty and students but also affords possibilities: Challenge-based learning experiences further harness the desire of many students for a sense of meaning with their education while effectively training key skills such as multidisciplinary teamwork and decision-making, advanced communication, ethics and leadership of self and others (p. 8.) These examples show a more critical understanding of CBL (see also Rådberg et al., 2015), but the low numbers of articles indicate that a problematised discussion often is missing when CBL is reduced to a model for pedagogic intervention.

Frame, discussion, and combined analytic models

The theme (n = 7) covers how CBL is used as an analytic model together with other perspectives. The theoretical roots of CBL are not only recognised but also used analytically and discussed in relation to a variety of disciplines (Jensen et al., 2018). Sternad (2015) draws on CBL to present a model for feedback in international business education. The model is discussed from perspectives like goal-setting theory of human motivation, deliberate practice theory of expert performance, Kolb's learning cycle, case-based teaching, problem-based learning, and flexible adaptive instructional design. Sternad concludes:

CFL is not a model of explaining how people learn but a systematic approach by which students can gradually acquire skills for solving complex challenges in a collaborative effort. As the CFL approach is grounded in the findings on both motivational and expert performance theories, it provides a framework in which student motivation for learning and the structured acquisition of expertise come together. (p. 252)

Cruger (2018) aims to assess CBL as a feminist pedagogy with the argument that: CBL as pedagogy allows us to put theory to the test, albeit in an imperfect way, to address real problems outside safe classroom environments, work for social justice, and embody positive activism (p. 88). The author states that CBL combined with feminist pedagogy allows teachers to apply theory to daily practice. The article serves as an example of how a theoretical perspective and pedagogic idea, like feminist pedagogy, finds a concretisation and realisation within CBL. Or, in other words, it seems like the two perspectives enrich each other: / . . . /help students recognise and value the wealth of their existing knowledge and experience and assert that no single discipline (not even communication) is as useful for solving a problem as is collaboration across difference (p. 100).

Other examples discuss CBL with Direct Instruction (Gaskins et al., 2015) or through a fusion of CBL and CBI (challenge-based instruction) (Fidalgo-Blanco et al., 2016). Rosner and Högström (2018) explore CBL in relation to socio-ecological and social learning and includes theorists like Dewey and Bernstein. Bertoni (2019) applies design thinking as a core part of CBL and explores an innovation course in engineering with a focus on work integration social enterprises, that is both commercial and social. Iterative problem formulating and design are connected to Schön ideas on the reflective practitioner, and entrepreneurial mindset and value-driven learning are linked to entrepreneurial thinking, just to mention some examples of theoretical applications in the article. The author claims that the innovation course brings forward additional value compared to more traditional courses and unlike other articles in this study, Bertoni applies CBL to an educational

context, gathers empirical evidence, discusses the intervention, and then unpacks significant elements in the design with theories and relevant research.

This theme highlights how CBL is problematised and not only accepted as a way to educational change, even though all authors state the benefits of CBL as a pedagogical method. However, it seems that CBL alone is insufficient as an analytic frame for understanding an empirical result. When combined with other theories, CBL opens for analytic depth and critical reflection.

Frame, discussion, and other analytic models

In this theme (n = 3) CBL is used as a frame for a pedagogical intervention and discussed as such, but other theories are used for the analysis. In two articles (Meyer, 2018; Valenzuela et al., 2018) theories on experiential learning and teacher beliefs are used to discuss educational design projects in business education and engineering. In Högfeltdt et al. (2019) Challenge-Driven Education, a version of CBL, is framed by Activity theory. The argument for using activity theory is that the implementation of CDE in engineering education is complex with a risk of ending up as an extracurricular activity instead of a broader educational change process: Through the lens of Activity theory, it is revealed that with the implementation of CDE a negotiation is initiated related to the norms and the values of what engineering education really is as well as what it should look like in the future (p. 27).

Högfeltdt et al. analyses a longitudinal international implementation project and find that CDE is motivating for students and beneficial for their learning. They also discuss CDE on an organisational level:

Also, traditional organizational structures will need to be continuously negotiated in the light of the integration of more open-ended approaches in education/ ... /Finally, while many barriers for change will be removed by the teachers, students and the challenge providers, when implementing CDE, the norms and the rules of higher education will need to successively be in line with the intentions of the change, due to the open-ended nature of CDE. (p. 27)

In the theme different theories on learning, from a teacher perspective to an organisational level, are used to discuss CBL. In the material, CBL do not stand alone but are preferentially combined with other theoretical perspectives. To sum up, even if the articles are few in the last two themes, they may signal the way forward for CBL in HE, not only as a framework for critical doing, but also as a perspective for critical thinking and analysis of complex learning processes in HE.

Discussion

In this article the following questions are posed: What research has been published? How is CBL defined in HE settings in relation to the definition by Apple? How is CBL in HE grounded scientifically in the research?

The research ...

There are few research publications available on CBL within HE. We have identified 36 relevant articles in English during a period of 11 years. Most frequent countries are Spain

and the USA, followed by Mexico and Sweden. From a scattered amount of publications per year, there is a significant increase in 11 publications in 2018 followed by 8 in 2019. Engineering is the dominating discipline, but medicine and design are emerging. Even if many of the recent studies pinpoint aspects like multi-disciplinarity and sharing in their studies, the need to position CBL within a discipline seems to be stronger than the will to disseminate more generally to a broader circle of readers.

The definition . . .

Within HE the definition of CBL is partly coherent with the Apple definition. Over the years the focus on different aspects of the CBL definition has varied, but in the latest years, a majority of keywords appear in the publications. The keywords least used are take action and share. This may reflect the challenge for HE to integrate both critical thinking and critical doing to approach global and local challenges. Another keyword that's not so common is subject area knowledge which may implicate a risk that subject knowledge is being overshadowed by generic competencies.

The scientific ground . . .

CBL in HE is based on proven experience and theoretically grounded. However, a majority of the articles stay on a case-based, descriptive level, where CBL serves as a frame for some kind of pedagogical innovation, with none or limited problematising of the ideas behind CBL. Furthermore, a critical analytic approach towards learning, as could be expected within HE-settings, is marginally present in the majority of papers. One possible explanation could be the disciplinary dominance of engineering and publications within another scientific tradition than educational science with its focus on learning theories. On the other hand, the few articles that are informed by different learning theories highlights how CBL invites a holistic and critical understanding of knowledge production and learning processes in HE.

CBL has moved from being a concept coined by a multinational technology company targeting learning in schools, to now being adopted by HEIs, mostly as a method for transformation of adult learning in higher education. We argue that when CBL is used as a framework for educational interventions and not for societal impact, a central component of CBL is lost. Even if the latter may be the hardest aspect to instigate, HEIs as providers of knowledge in a learning society should be able to accept the challenge.

This study is just a first step in a direction of mapping CBL in HE. The limited scope means that several dimensions cannot be explored. One limitation is the narrow focus on CBL as a concept. With a broader approach, including other theories and methods that are not explicitly labelled CBL, a deeper understanding of a growing field could be developed. A comparison with other school forms might also be valuable. Furthermore, there is a need for research that explores CBL and student voices, praxis, and evidence on learning.

Disclosure statement

No potential conflict of interest was reported by the authors.

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