Stakes in the potential of technology-enhanced learning: a STEM faculty case study

Mikkel Godsk
Aarhus University
Denmark

To successfully enhance learning in higher education with technology, it is essential to understand the main stakes in the potential of technology-enhanced learning. This paper presents a case study of these stakes at a traditional, campus-based STEM faculty. Based on four surveys, the paper identifies which potential educational purposes of technology that are prioritised by the management, the educators in general, the educators engaged in Learning Design, and the students in general as well as which prioritisations that are convergent and divergent. Furthermore, the paper discusses how these stakes may inform building an efficient Learning Design practice.

Keywords: Technology-enhanced learning; Learning Design; stakes in TEL; efficiency; STEM.

Background

There is a widespread, general political agenda at universities that technology-enhanced learning (TEL) should improve, modernise, and make teaching more efficient (Daniel et al., 2009; The Government, 2016). However, the agenda rarely provides answers on how to efficiently enhance teaching with technology nor how to intepret the concepts of 'improved learning' and 'efficiency'. Recently, the Learning Design (LD) methodology has gained foothold as an educational development methodology across in particular Australasia and Europe for introducing technology in an efficient manner (Dalziel et al., 2016; Godsk, 2018). LD is characterised by educators being active designers of student-centred TEL supported by practical design aids and pedagogy theory as well as an underlying idea of sustainability in terms of supporting educators in developing, representing, sharing, and reusing effective teaching practices (Conole, 2013; Conole & Oliver, 2002; Dohn et al., 2019). This also means that LD has the potential to support an efficient introduction of TEL if effective practices are shared and disseminated. Nevertheless, to build an effective and efficient TEL and LD practice in higher education, it is important to look into how 'improved learning' would be perceived by understanding the main stakes in the potential of TEL.

The Faculty of Science and Technology (ST) is a large-scale, campus-based, research-intensive STEM faculty at Aarhus University (AU), Denmark. ST is one of the university's four faculties and has a total of 3,022 full-time equivalent staff (FTE), of which 1,696 FTEs are in full-time academic positions, and it has 7,045 students (in 2018). ST had a turnover of EUR 334 million in 2018 (Aarhus University, 2019), equivalent to 38% of AU's total turnover, of which the vast majority originates from research grants. Evidently, this balance makes research the top priority of the faculty. Nevertheless, an ambitious strategy for TEL was launched in 2011 (Aarhus Universitet, 2011) and further specified in 2018 (Aarhus Universitet, 2017; 2018) making the integration of technology in education a strategic priority supported by the Board, the pro-vice-chancellor (PVC), and the vice-deans responsible for education. The overarching, explicit aim of the integration at the institutional level is to improve the quality of the education and increase learning, and implicitly also to comply with government digitalisation goals (Aarhus Universitet, 2017; 2018). On faculty level, the aims are to support preparation before in-class teaching, create opportunities for more and better feedback, facilitate a progression of students' independence during their studies, support the development of collaborative and reflective competencies, and give educators insight into students' learning outcome and level of understanding (STLL, 2019) — in addition to any module-specific goals the educators may have. That is, in most cases TEL is not expected to be a vital component to facilitate the teaching. In 2019, it is estimated that less than 10% of the modules across AU include online activities and thus may be considered as 'blended' or 'online'. In addition, as most students are living close to and attend lessons on campus, the ambitions are primarily concerned with improving what happens before, during, and after these lessons instead of, e.g., providing online modules and programmes.

No specific educational development methodology has been provided at AU and, thus, it is up to ST and its educational unit to decide on a suitable methodology. Due to limited funding as well as negative experiences with the previous ad hoc-approach to technology-enhancement of modules, the educational unit adopted a Learning Design methodology in 2013 (Godsk & Hansen, 2016). The purpose was, in particular, to integrate technology in teaching and learning in a pedagogy-informed way using practical and suitable pedagogical models and other design aids as well as make the development efficient by supporting documentation, sharing, and reuse of good practice. However, to make this methodology efficient, one of the first questions that arise is on the actual interests in the technology's role and impact — or phrased as a research question: 'what are the main stakes in the potential of TEL in STEM undergraduate education?'

Methodology

The study was carried out using four online surveys in SurveyXact; one for each stakeholder: the institution, the educators in general, the educators engaged in Learning Design, and the students in general. Each survey included a corresponding battery of nine Likert-scale sub-questions on the potential of technology in higher education based on the nine identified themes of documented educational purposes of TEL in Price and Kirkwood's (2011) synthesis of evidence of technology in higher education. The questions were phrased in such a way that each respondent was asked to rate these nine purposes on a six-point Likert scale ranging from 'not at all' (0), 'a very limited extent' (1), 'a limited extent' (2), 'a certain extent' (3), 'a high extent' (4) to 'a very high extent' (5). The institutional stakeholder was asked to rate the educational purposes according to its importance for teaching at the university and faculty in general, whereas the educators were asked to rate the educational purposes regarding their teaching in general or the module they were designing. The students were asked to rate the educational purposes according to their studies in general.

The institutional perspective was represented by the PVC who represents the strategic level at the university and is the most senior responsible for teaching and learning at the university, and the head of the educational unit at the faculty responsible for the operational level. These two sub-surveys were carried out in December 2016 and November 2017. The educator perspective was represented by all science module responsible educators at the faculty (N = 397) and was carried out June–July 2015. 213 completed and 14 partially completed the survey, which corresponds to a 57% response rate and a 4.3% margin of error with a 95% confidence interval. 10 educators actively involved in an organised Learning Design process from 2018 to 2019 also represented the educator perspective. All first-year science students represented the student perspective. The survey was carried out in January 2015, which means that most of the students at that time would have participated in six undergraduate modules. 361 completed and 35 partially completed the survey, which corresponds to a 44% response rate and a 3.9% margin of error with a 95% confidence interval. This means that there is high confidence with the results on the institutional, educator, and student perspectives, whereas the results on the educators engaged in Learning Design mostly serve to provide perspective due to the low quantity. Upon completion of the surveys, the data was collected from the survey tool and processed in Excel for calculating average prioritisations (Mean), standard deviations (SD), and rankings (see Table 1).

Stakes in the potential of TEL

Table 1 illustrates the four stakeholders' average prioritisations of the nine educational purposes, together with their SD and ranking. The table shows several convergent and divergent views on the purposes that the technology may play — either between the different stakeholders or within the individual stakeholder groups (indicated by a high SD value).

Table 1: The main stakeholders' prioritisations of the educational purposes of technology

Stakeholder	Institution (n = 2)			Educators (all) (n = 219)			Educators (learning design) (n = 10)			Students (all) (n = 322)			All stakeholders (equal weight*)		
(Item) Educational purpose**	Mean	SD	Rank	Mean	SD	Rank	Mean	SD	Rank	Mean	SD	Rank	Mean	SD	Rank
(1) That the students can study from where they want and do not always have to come to campus	2.5	0.5	8	1.88	1.12	9	2.5	1.6	9	3.22	1.43	9	2.74	0.68	9
(2) That the students can repeat lectures and other teaching activities as they prefer	2.5	0.5	8	2.34	1.10	8	3.7	0.7	6	3.87	1.08	6	3.35	0.84	8
(3) That feedback is provided to the students' learning process, their assignments, and answers to their questions	4.0	0.0	3	4.16	0.76	3	4.0	0.7	3	4.37	0.89	1	4.12	0.19	3
(4) That the students learn to link theory to practice	4.0	1.0	3	4.18	0.83	2	3.9	1.3	4	4.17	1.05	4	4.02	0.10	4
(5) That the students develop skills for a future job	4.5	0.5	1	3.87	0.96	4	4.2	0.8	2	4.06	1.06	5	4.26	0.32	2

(6) That the teaching supports collaboration and interaction among the students	3.5	0.5	7	3.79	1.00	6	3.7	0.9	5	3.68	1.11	8	3.63	0.15	7
(7) That the students find the teaching and learning is enjoyable	4.0	0.0	3	3.81	0.92	5	2.7	0.5	8	4.33	0.88	2	3.67	0.27	5
(8) That the examination reflects the curriculum and skills the students are supposed to have learnt	4.5	0.5	1	4.46	0.62	1	4.3	0.7	1	4.33	0.94	3	4.36	0.09	1
(9) That the teaching is in complete concordance with the formal requirements (i.e. learning goals and the estimated study time/ECTS)	4.0	0.0	3	3.39	1.18	7	3.1	1.6	7	3.81	1.13	7	3.65	0.31	6

*Equal weight is the average prioritisation of the institutional, educator, and student perspectives. **The educational purposes were phrased in the first person and Danish in the student survey.

It can be observed that all stakeholders find feedback to the students (item 3), linking theory to practice (item 4), and examination alignment (item 8) of high importance. Furthermore, all stakeholders find that students developing skills for a future job (item 5), collaboration and interaction among students (item 6), and teaching in concordance with formal requirements (item 9) are of some or high importance. Primarily the institution, the students, and, to some extent, the educators in general prioritise that students find teaching and learning enjoyable (item 7); however, this is of less concern to the educators involved in an actual Learning Design process. The place and pace flexibility potential of TEL (items 1 and 2) is of limited interest to all stakeholders; however, students and the educators involved in Learning Design are generally more interested in this than the other stakeholders.

Nevertheless, the SD values suggest that there is a diverse view on educational purposes within some stakeholder groups. For instance, a considerable share of the educators and students find the flexibility highly important, while others find it of little importance. In addition, a similar high variance exists among the views on the support for collaboration and interaction; the concordance with formal requirements; and linking theory to practice. The variance of the last two is particularly significant for the educators engaged in Learning Design. Comparing the two groups of educators, particularly the purpose of developing the students' skills for a future job and providing place flexible learning has a higher priority among the educators engaged in Learning Design. This suggests that there may be very diverse aims of enhancing learning with technology and that these aims may change and/or become more tangible when an educator becomes actively involved in Learning Design.

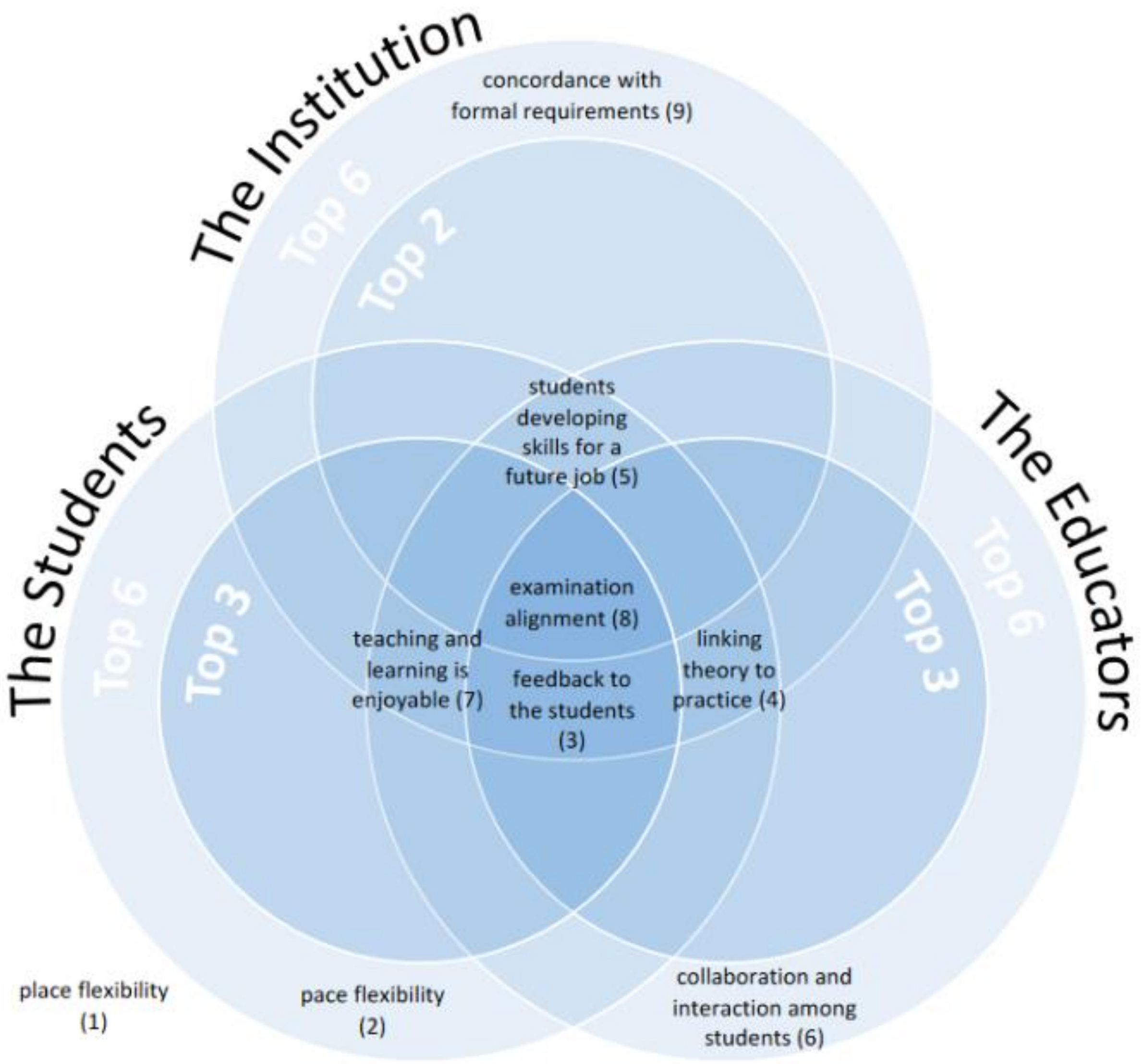

Figure 1: The convergence of the Top 2–3 (the inner circle) and Top 6 (the outer circle) prioritisations of the three main stakeholders in general. The digits refer to the item numbers.

However, as it is "cost-free" to assign high priority to all of the educational purposes, it also relevant to compare the ranking of the different items. Figure 1 shows a Venn diagram of which prioritisations with the highest rankings that are convergent among the institution, the educators, and the students in general. This illustrates that despite all stakeholders are assigning high priority to most of the educational purposes of technology (Table 1) there are pivotal differences. For instance, the institution is highly concerned with the aspects relating to teaching in concordance with formal requirements and technology used for developing the students' skills for a future job. However, the students are generally less concerned with these purposes and more interested in the pace flexibility, the feedback, and the enjoyable teaching and learning that the technology may provide. Likewise, the educators prioritise being able to support the students' collaboration and interaction as well as linking theory to practice through technology.

Building an efficient Learning Design practice

According to Encyclopaedia Britannica (2019), “efficiency” is defined as ‘a measure of the input a system requires to achieve a specified output. A system that uses few resources to achieve its goals is efficient…’. Thus, in the context of a Learning Design practice, efficiency is the balance between the efforts associated with the facilitation, design, implementation, and teaching/learning processes; and the impact it has on its stakeholders, such as the institution, the educators, and the students when enhancing learning with technology (Godsk, 2018). Often impact is assessed based on the students’ learning experience (Davids et al., 2013; Dawson et al., 2010; Pejuan et al.,

2012). However, it can also be assessed based on the institutional and educator perspectives, such as sustainability and cost-efficiency (Atkinson, 2011; Bai & Smith, 2010; Brown & Voltz; 2005; Daniel et al., 2009; Elliott & Sweeney, 2008; Godsk, 2018; Pankratius et al., 2005). In any case, this highlights the importance of understanding the interests in technology in education and that impact needs to be interpreted accordingly.
As Table 1 shows, generally there is a high level of interest in the educational purposes TEL may actualise. In particular, feedback, linking theory to practice, and examination alignment are of high common interest. Table 1 and Figure 1 also show that enjoyable teaching is of high interest to the students and the institution, and that flexibility is of high interest to some students and educators, but not all. The difference between the prioritisations of the educators in general and the educators engaged in Learning Design as well as within the group of designing educators suggest that interests will often be linked to the actual purpose of integrating technology in a specific module and differ from the general perspective.

That is, building a Learning Design practice that supports actualising some of these highly desired impacts of TEL as well as any additional strategic and module-specific aims has the potential to be interpreted as effective. Furthermore, the efforts ("inputs"), such as the costs and the sustainability of the Learning Design practice should be considered when assessing its efficiency. That is to say, to build an efficient Learning Design practice the main stakeholders' prioritisations of the educational purposes of technology, any additional strategic and module-specific aims with the integration of technology, and the various efforts associated with facilitating the Learning Design process and practice in general should be considered. At ST, this knowledge is used to inform the current Learning Design practice by assessing the efforts and impacts of Learning Design initiatives according to the stakeholders' prioritisations, including the module-specific aims.

Conclusion

Technology in higher education is often portrayed as a way to improve quality in higher education and make teaching more efficient, and Learning Design has the potential to introduce technology effectively and efficiently. However, to improve quality with technology, it is essential to understand what the main stakes in the potential of TEL are and use this to inform Learning Design practice. This paper has presented a case study of the main stakes in the potential of a TEL at a traditional, campus-based STEM faculty. The study revealed that there are several joint views on TEL as well as significant differences. These differences appear to be linked to the role of the stakeholder: the institution is highly concerned with aspects such as formal requirements and employability, the educators are concerned with aspects they believe will ensure good teaching, and the students are concerned with their own learning experience and preferences. This is not a surprising difference, but it suggests that there are diverse conceptions of and expectations to the educational purposes of technology in education. Furthermore, it also indicates how TEL initiatives will be perceived and thus the potential impact it will have on the main stakeholders. In the context of Learning Design, this may help to identify and build practices that efficiently support the integration of technology.

Though ST is traditional STEM faculty that most likely share characteristics with a large number of similar faculties, the exact prioritisations will vary. Thus, it would be relevant to conduct similar surveys at other faculties to further investigate to what extent the prioritisations apply.

References

Atkinson, S. P. (2011). Embodied and embedded theory in practice: The student-owned learning-engagement (SOLE) model. *The International Review of Research in Open and Distance Learning, 12*(2), 1–18. http://dx.doi.org/10.19173/irrodl.v12i2.929

Bai, X., & Smith, M. B. (2010). Promoting Hybrid Learning through a Sharable eLearning Approach. *Journal of Asynchronous Learning Networks, 14*(3), 13–24.

Brown, A. R., & Voltz, B. D. (2005). Elements of effective e-learning design. *The International Review of Research in Open and Distance Learning, 6*(1). http://dx.doi.org/10.19173/irrodl.v6i1.217

Conole, G. (2013). *Designing for learning in an open world.* New York: Springer.

Conole, G., & Oliver, M. (2002). Embedding theory into learning technology practice with toolkits. *Journal of Interactive Media in Education, 2002*(1).

Dalziel, J., Conole, G., Wills, S., Walker, S., Bennett, S., Dobozy, E., Cameron, L., Badilescu-Buga, E., & Bower, M. (2016). The Larnaca Declaration on Learning Design. *Journal of Interactive Media in Education*, 2016(1). http://doi.org/10.5334/jime.407

Daniel, J., Kanwar, A., & Uvalić-Trumbić, S. (2009). Breaking higher education's iron triangle: Access, cost, and quality. *Change: The Magazine of Higher Learning, 41*(2), 30–35. http://dx.doi.org/10.3200/CHNG.41.2.30-35

Davids, M. R., Chikte, U. M., & Halperin, M. L. (2013). An efficient approach to improve the usability of e-learning resources: the role of heuristic evaluation. *Advances in physiology education, 37*(3), 242–248. http://dx.doi.org/10.1152/advan.00043.2013

Dawson, S., Heathcote, L. & Poole, G. (2010). Harnessing ICT potential: The adoption and analysis of ICT systems for enhancing the student learning experience. *International Journal of Educational Management, 24*(2), 116–128. http://dx.doi.org/10.1108/09513541011020936

Dohn, N. B., Godsk, M., & Buus, L. (2019). Learning Design. *Tidsskriftet Læring og Medier (LOM), 12*(21). https://doi.org/10.7146/lom.v12i21.112639

Elliott, K., & Sweeney, K. (2008). Quantifying the reuse of learning objects. Australasian *Journal of Educational Technology, 24*(2), 137–142. https://doi.org/10.14742/ajet.1216

Encyclopaedia Britannica (2019). Efficiency | economics and organizational analysis | Britannica.com. Retrieved 27 Jun 2019 from https://www.britannica.com/topic/efficiency-economics-and-organizational-analysis.

Godsk, M. (2018). *Improving STEM Undergraduate Education with Efficient Learning Design*. EdD Thesis. The Open University. Retrieved from http://oro.open.ac.uk/55045/

Godsk, M., & Hansen, J. S. (2016). Learning design som systematisk alternativ til one-hit wonders–implementering af educational it i de våde fag på Aarhus Universitet. *Tidsskriftet Læring og Medier (LOM), 9*(15). https://doi.org/10.7146/lom.v9i15.23127

The Government, Local Government Denmark and Danish Regions (2016). *The Digital Strategy 2016–2020 - A STRONGER AND MORE SECURE DIGITAL DENMARK*. Retrieved from https://digst.dk/media/16165/ds_singlepage_uk_web.pdf

Pankratius, V., Stucky, W., & Vossen, G. (2005). Aspect-oriented re-engineering of e-learning courseware. *The Learning Organization, 12*(5), 457–470. http://dx.doi.org/10.1108/09696470510611401

Pejuan, A., Bohigas, X., Jaén, X., & Periago, C. (2012). Misconceptions about sound among engineering students. *Journal of Science Education and Technology, 21*(6), 669–685. http://dx.doi.org/10.1007/s10956-011-9356-6

Price, L. & Kirkwood, A. (2011). Enhancing professional learning and teaching through technology: a synthesis of evidence-based practice among teachers in higher education. Higher Education Academy, York, UK. Retrieved from http://oro.open.ac.uk/30686/1/1_PLATP_main_report.pdf

STLL (2019). Educational IT at Science and Technology. Retrieved August 9, 2019, from http://stll.au.dk/en/development/projects/educational-it/

Aarhus Universitet (2011). Den Faglige Udviklingsproces. Øvrige bilag. Universitetsledelsen den. 9. marts. Retrieved November 21, 2013, from http://medarbejdere.au.dk/fileadmin/res/fau/dok/fau_bilag_oevrige_bilag_090311.pdf

Aarhus Universitet (2017). Digitaliseringsstrategi. Retrieved August 9, 2019, from https://medarbejdere.au.dk/fileadmin/www.medarbejdere.au.dk/Medarbejderservice/IT/Medarbejderservice_AU_IT/Projekter/Digitaliseringsstrategi.pdf

Aarhus Universitet (2018). Strategisk rammekontrakt 2018-2021. Retrieved August 9, 2019, from http://www.au.dk/fileadmin/www.au.dk/om_au/strategi_og_politik/udviklingskontrakt/AU_Strategisk_rammekontrakt_2018-21_dansk__underskrevet.pdf

Aarhus University (2019). Key statistics for Aarhus University. Retrieved from https://international.au.dk/about/profile/keystatistics/

Please cite as: Godsk, M. (2019). Stakes in the potential of technology-enhanced learning: a STEM faculty case study. In Y. W. Chew, K. M. Chan, and A. Alphonso (Eds.), *Personalised Learning. Diverse Goals. One Heart. ASCILITE 2019 Singapore* (pp. 424-429).