



Faculty change in engineering education: Case study of a blended course about blended and online learning

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**Faculty change in engineering education:
A case study of teaching faculty about blended and online learning**

Abstract

This paper reports results from a case study of teaching development in engineering education at KTH Royal Institute of Technology in Stockholm, Sweden, in answer to the research question “what impact, if any, does participation in a blended course about teaching in blended face-to-face and online formats have on faculty views about teaching in engineering education?” Early results indicate that 1) faculty can assess the value of online and blended learning through this experience, 2) faculty engaged actively in online and face-to-face discussions of pedagogy, 3) disciplinary differences in the application of online and blended learning are a concern to STEM faculty, and 4) the evaluation and implementation, if any, of online and blended learning in engineering education has to include discussions beyond the use of applicable technologies.

Introduction

Engineering education takes place in a traditional university environment, and, disciplinary differences aside, engineering faculty are experiencing all the pressures to change now being imposed on higher education. The opportunity to move engineering education to online and blended delivery is one example. According to Bourne, Harris, and Mayadas (2005)¹, it likely that to “satisfy the need for more trained engineers in the workforce, there might logically be a greater need for online B.S. degrees in engineering” (p. 140). In the broader higher education enterprise in which engineering education resides “there is evidence of increasing amounts of such delivery” (Allen & Seamen, 2011)² reshaping higher education through web-based content delivery and interaction. To respond appropriately to this potential change in teaching and learning requires that engineering faculty understand the applications and implications of such a change. The course offered in this case study provides faculty both the experience of learning in a blended course format, and instruction about a well-researched framework for teaching in a blended course (Garrison, Anderson & Archer, 2001)³.

Understanding online and blended teaching and learning in higher education occurs in tandem with a need to address quality teaching overall. Improving teaching is a long standing challenge in higher education where faculty are not certified to teach. In order to use online and blended learning *and* maintain or enhance quality teaching, more faculty review and experimentation is required (Ikenberry, 2001⁴; Keller, 2008⁵). The success of online or blended learning delivery is, to a large extent, dependent on the pedagogical knowledge and expertise available in the transition to this new way of learning. This expertise must be developed among all faculty; engineering education is no exception (Quinn, Amer, Lonie, Blackmore, Thompson & Pettigrove, 2012⁶; Shambhavi & Babu, 2015⁷).

An opportunity for faculty to develop skill and expertise in teaching both placed-based and online, education developers at KTH Royal Institute of Technology created a course entitled *Teaching Strategies and Design for Online and Blended Learning* (see Appendix A for a copy of the course syllabus). The course is equivalent to two weeks of full-time studies. KTH, and most higher education institutions in Sweden, require at least ten weeks of full-time studies in the field of teaching and learning in order to be tenured.

In order to assess the value participants found in the experience of learning in an online and blended environment while studying teaching in online and blended environments, we created a

data collection process to answer the research question “What impact, if any, does participation in a blended course about teaching in blended face-to-face and online formats have on faculty views about teaching in engineering education?”

Literature Review

Engineering education exists in the wider field of higher education and is therefore subject to the same demands for change. This literature review begins with a discussion of the need for change in teaching and learning in higher education, and where training in online and blended learning may fit. Review of specific research in online engineering education follows.

According to Rhoades, "... classroom teaching and course materials (have become) more sophisticated and complex in ways that translate into new forms of faculty work...such new forms are not replacing old ones, but instead are layered on top of them, making for more work" (2000, p. 38)⁸. Even before the imposition of new technology, both excellent teaching *and* excellent research records were difficult to achieve. Fairweather's (2002)⁹ research suggests that new ways of teaching will make it more difficult for faculty to be exemplars of research and teaching. Data from the 1992–93 National Survey of Postsecondary Faculty provided a representative sample of 29,764 part-time and full-time faculty in 962 American research universities, doctoral-granting universities, comprehensive colleges and universities and liberal arts colleges. For the purpose of that study, Fairweather identified faculty as highly productive researchers if refereed publications exceeded the median for program and institutional type over a two year period. Faculty members identified as highly productive teachers were those above the median in student classroom contact hours. In the first instance, 22% of faculty in 4-year institutions met both criteria. However, adding collaborative instruction, a central part of online learning, to the teaching criterion reduced the percentage of highly productive researchers and teachers to about 6%.

Although time consuming, collaborative instruction is central to the benefits of online teaching and learning. The individualization of communications, and the role of instructor as a facilitator of student participation and learning, add to instructor workload when teaching online (Davidson-Shivers, 2009)¹⁰. A central teaching advantage of online delivery is the opportunity to better engage learners in more active and collaborative educational experiences. Tomei (2004)¹¹ proposes that online student expectations for on-demand, continuous feedback necessitates smaller class sizes relative to those in traditional classroom instruction. Reducing class size is one option available to compensate for the imposition of time online teaching will impose; a value added in any delivery method. For Tomei then, the 40-40-20 formula for allocating faculty time (40 percent teaching, 40 percent research, and 20 percent service) suggested by the American Association of University Professors (AAUP) must be reshaped for faculty teaching in an online environment. It is unrealistic then to assume that emerging Internet technologies will transform teaching practices in higher education without changing how faculty work. (Yick, Patrick, & Costin, 2005)¹².

To attend to this unique need, this case study describes an education experience for KTH faculty who are interested in online and blended learning design. This course was created with reference to multiple learning theories and delivery opportunities. First, the textbook and the orientation to design and delivery in this course are based on the online Community of Inquiry model

(Garrison, Anderson & Archer, 2001³; Vaughan, Cleveland-Innes, & Garrison, 2013¹⁴). This model is based on Dewey's (1910)¹⁵ views on experiential learning and is constructivist in nature. The role of instructor and student are transformed by three overlapping presences: cognitive, social, and teaching presence. Social presence is defined as the extent to which learners are socially and emotionally connected with others in an online environment; cognitive presence describes the degree to which learners are able to construct and confirm meaning through sustained reflection and discourse. The central organizing element is teaching presence. Teaching presence is available to the instructor and the students. It is created through the design, facilitation, and direction of cognitive and social processes such that personally meaningful and educationally worthwhile learning outcomes are realized. See Appendix B for a chart of course activities.

Ensuring educationally worthwhile outcomes in engineering education requires using pedagogical methods that are instructional themselves. According to Yigit, Koyun, Yuksel, & Cankaya (2014)¹⁶, “algorithmic thinking abilities of students who enrolled in the Algorithm and Programming course in blended and traditional education are close” (p. 1). While not specific to engineering curriculum, these thinking abilities emerge in the learning environment and must be maintained. For Shambhavi & Babu (2015)⁷ blended learning is “successful in providing an efficient and effective learning experience to both students and faculty” (p. 313). In addition, online and blended learning could be a remedy for some of the challenges in engineering education, where there is a call to “adopt strategies and tools for using a multiple perspectives approach to better understand complex engineering education problems” (Adams, Evangelou, English, de Figueiredo, Mousoulides, Pawley, & Wilson, 2011, p. 48)¹⁷. Engaging engineering faculty in review and discussion about new pedagogies like online and blended learning provides great benefit to engineering education overall.

Methods

A case study method is an emerging methodology in engineering education (Case & Light, 2011)¹⁸ and was chosen to “allow the research community to be able to better address questions around key engineering education challenges ...” (p. 186). Case study research is an acceptable choice of method where the purpose is to explore, describe, or explain a specific premise or instance of a bounded but complex environment. This exploratory study is a test of the theoretical premise that experience in a particular phenomenon will provide the opportunity to evaluate the value of such. In this case, faculty experience in an online and blended learning environment to learn about teaching in blended courses.

Description of the case. KTH was founded in 1827 as the premier technological school in Sweden, offering subjects in science with a decided practical, professional focus. This makes KTH Sweden's oldest technical university. It is also the largest; approximately one-third of Sweden's technical research and engineering education capacity at university level is provided by KTH. Currently, 13,400 first and second level students and 1,900 doctoral students study at KTH.

KTH has remained a leading-edge institution since its inception. Recently, KTH created a Vision 2027 strategy: “Information technology as an integral part of everyday life has altered conditions for university studies fundamentally by 2027. Competition is becoming global when courses, to an ever larger extent, are offered via cloud computing networks and when teaching materials are

becoming omnipresent. e-education is a self-evident part of competitive bids for university studies. There is a special challenge in acquiring and maintaining a leading position in both ICT research and e-education.”

The teaching development initiative reported here responds to the above vision and to two calls for change in higher education. The first, identified in the introduction, is the need to improve expertise on teaching and learning among faculty in higher education. The second, as indicated in KTH’s vision, is to create expertise among faculty regarding e-education, and the use of ICTs for teaching and learning.

An opportunity for faculty to develop skill and expertise in online and blended learning, education developers created a course entitled *Teaching Strategies and Design for Online and Blended Learning*. The theoretical part of the course employed the model of Constructive Alignment framework (Biggs, 1996)¹³ introduced in previous courses. An additional theoretical framework used for this course is the extensively researched theory of an online Community of Inquiry (Vaughan, Cleveland-Innes, & Garrison, 2013)¹⁴. The Community of Inquiry theoretical framework represents a process of creating a deep and meaningful (collaborative-constructivist) learning experience through the development of three interdependent elements - social, cognitive and teaching presence.

In the application part of the course participants design a module of online and/or blended learning. The module is to be implemented in a course or session in their own field. Application practices allow participants to test and evaluate tools and techniques often used in online and blended education. The tools are chosen among those which are KTH-supported and any external tools needed to meet the appropriate theoretical framework and personal requirements.

This course itself is delivered in blended mode. This means that some activities in the course will be delivered face-to-face and some online. The course is 3 credits, which corresponds to 80 hours workload.

Participants in this case study hold positions related to instruction at KTH. Participation is voluntary. Credits received for taking the course satisfy pedagogical training requirements; in order to be appointed as associate or full professor at KTH, faculty must have 10 weeks of courses in teaching and learning in higher education.

Data sources

Data sources for this case study were drawn from all 21 participants and are the following: 1. Pre-course survey responses; 2. Forum discussion posts; 3. Participant activities and responses in face-to-face classes and 4. Post-course survey results. Data were collected from two separate course offerings, Fall 2013 and Fall 2014.

Preliminary content analysis was performed on data. The process included multiple reviews of textual data with identification of salient responses in reference to the research question. As indicated by Cohen, Manion, and Morrison (2007)¹⁹, “Qualitative data analysis involves organizing, accounting for, and explaining the data; in short, making sense of data in terms of the participants’ definition of the situation, noting patterns, themes, categories, and regularities” (p. 461).

At the time of writing, only open coding of data sources is complete. According to the requirements of authenticity and verifiability required in qualitative data analysis (Neuman, 2011)²⁰, only themes that 1) respond specifically to the research question and 2) were referenced in at least two of the four data sources are reported. Four themes met both criteria. These themes will be further tested with axial and confirmatory coding by at least two coders in our continuing data analysis.

Findings

A total of 21 faculty participated in two sections of this course, one year apart. These faculty represented the following sub-disciplines in engineering and computer science: Aeronautical and Vehicle Engineering, Communication in Engineering Science, Computer Science and Communication, Education in Engineering Science, Electromagnetic Engineering, Engineering Mathematics, Environmental Management and Assessment, Engineering Physics, Materials Science, Power Engineering and Production Engineering.

Participant communication from multiple sources of data yield the following general themes in answer to the research question: : What impact, if any, does participation in a blended course about teaching in blended face-to-face and online formats have on faculty views about teaching in engineering education?

Value of online and blended learning. This theme was identified in text-based, participant responses. It refers to statements that include a judgment in reference to the use, and the impact of this use, of new pedagogies, blended learning or online learning. This assessment of value is often paired with words that inferred an emotional response in reference to potential change. These emotional responses were considered in reference to both positive (there is value here) and negative (this is of no benefit) assessment of possible changes.

Participants responded with a mixture of excitement, skepticism, anxiety, curiosity, and resolution. Few suggested that online and blended learning would not be part of their future teaching practice. Participants in each session felt that the integration of online activities might be interesting; some were unclear or concerned that the extra work would yield little pedagogical benefit. Others openly recognized the opportunity for leadership and active learning for students. Peer to peer learning was considered a benefit and one that could be supported through online learning environments. Some referred to online activity as adding more work for the instructor while others saw the opportunity to move some activities strictly to online discussion that could be managed by students.

Increasing pedagogical knowledge: All participants had previously taken a foundation course in teaching and learning in higher education. Some indicated the learning theory provided as key to understanding blended learning was very helpful, more helpful than theory in the prerequisite course. Reviewing the conceptual framework of online learning and the potential student activities and growth potential led to serious discussion about student engagement and learning support. Interaction was repeatedly mentioned; debate about the differences between face-to-face and online interaction ensued. Faculty who had moved beyond lecture-based delivery into project-based learning were more likely to suggest that face-to-face interaction will yield greater benefits than online interaction. This led to consideration of the difference in cognitive processes

between spoken interaction in the immediate moment and reflective written interaction over time.

Disciplinary focus: A common response by faculty discussing teaching adjustments relates to disciplinary uniqueness; does this apply to my discipline or subject-area? The textbook and examples in the course are generic in the beginning as materials reference an abstract model of teaching and learning online. Application to specific subject areas was a regular discussion. Individual faculty responded positively when course instructors provided materials that were specific to their discipline.

Beyond tools and tips: Faculty were very interested in technological tools and software applications. They were also ready and willing to go beyond tool usage to serious debate about value, benefit, time constraints, and student engagement in reference to such tools. This small group of faculty were well beyond the application of technology for technology sake. Serious thought, effort, and debate was a major part of any reference to technology usage in terms of learning activities and student growth and development.

Discussion

Outside of the more direct outcomes of applying blended opportunities in courses, faculty report value in the opportunity to reflect more deliberately on teaching practice and find discussing whether to blend or not a significant opportunity to think about what counts as good teaching, and about how students learn.

Disciplinary differences play a significant role in the determination of teaching and learning practices. The literature of epistemological and value-based differences across academic disciplines in higher education has a rich history. Biglan's (1973)²¹ Taxonomy of Disciplinary Differences codes academic disciplines along three dimensions: 1) the existence of a dominant paradigm, 2) a concern with application, and 3) a concern with life systems. These dimensions are identified as hard/soft, pure/applied, and life/non-life respectively.

Course activities had to bridge what engineering faculty are familiar with in learning and teaching hard disciplines on one-hand, and the more open, debatable pedagogical concepts in education. Engineering is, according to disciplinary differences categorized by Biglan (1973)²¹, is a hard, applied discipline. The content in this blended environment is from a relatively new, soft, applied content area where concepts and outcomes are much more open to debate. While the applied approach is shared between education and engineering, the difference between soft and hard disciplines is significant. In a hard discipline like engineering, the degree of definition and consensus in the field leaves less room for student construction of knowledge and requires more direct instruction. In the field of education, principles and practices have wide reaching application and are open to debate (Arbaugh, Desai, Rau, & Sridhar, 2010)²². This creates two challenges. One, engineering faculty expect concrete data and instructions rather than open-ended debate and questioning. The course had to be taught with both. Two, online and blended learning formats support high levels of activity and debate. Faculty were required to consider where, if at all, they could leave answers to be discovered rather than taught in their individual courses.

Integrating theory and experience shapes new forms of pedagogical practice. All participants had experience as instructors. A small range of experience teaching online existed in each group of participants, but in neither case were their individual participants who could claim to be expert in online and blended learning. Many could, however, claim to be expert teachers.

The following observations are provided by the course designers/instructors.

1. Participants from the first running of the course requested an ‘alumni’ meeting one year later. Of the original 13, seven participants attended this reunion meeting to discuss progress to date. Most had integrated some type of increased online opportunity, and were reviewing outcomes and considering other ideas. Development of a collegial support group or ongoing institute for research and practice in online and blended learning is under consideration.
2. There was a distinct difference in acceptance of two types of online teaching: asynchronous (online LMS learning communities supported by text-based communication) and synchronous audio discussions via AdobeConnect. There was a general sense that synchronous AdobeConnect sessions are unnecessary where face-to-face classes are offered.
3. The sequence, pace, and timing of face-to-face and online classes was different in course session one and two. The online discussion board was available throughout in both sessions, but the focus and activity was 1) more active throughout the course in session one, 2) more active in the first few weeks, and 3) much less in later weeks in session two. Future course sessions will seek to maintain a consist level of activity throughout the course in the online asynchronous community. Our preliminary assessment is that community builds as time goes on through regular engagement, infusion of material, and communication.

Conclusions

This exploratory case study provides a description of the case, summaries of faculty responses in reference to the research question using multiple data points, and conclusions based on data

collected from multiple sections of a course in online and blended learning. These features are legitimate parts of case study research (Mills, Durepos, & Wiebe, 2009)²³. Early analysis of findings indicates KTH faculty show a keen interest in using technology for learning but demonstrate somewhat less interest in the pedagogical frameworks underlying such use. Interest in creating blended teaching methods increased with discipline-specific examples (such as Martinez-Caro & Campuzano-Bolarin, 2011)²⁴ and opportunities to work collaboratively. Most valuable were intense discussions of pedagogy in reference to student needs. This extended to choices about what strategies to use in the classroom, and how the online could replace, enhance, or interfere with classroom environments.

Classroom teaching remained the gold standard for participants, but online and blended learning was given serious consideration. Most participants were open to considering how online and blended learning might be of benefit, either by saving instructor time or improving the learning experience for students. In this case at KTH, the transition to online and blended learning is seen as a *fait accompli*.

Further questions remain to be answered. How do we assist faculty to use the available technology? How do we improve pedagogy AND use the technology? What are the benefits of online and blended learning specifically for engineering? What's the best blend? Data from this case study will continue to be analyzed and further research will ensue.

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Appendix A: Course Syllabus

Teaching Strategies and Design for Online and Blended Learning

Strategier för och design av nätbaserad utbildning

Credits: 3.0 ECTS

Course code: LH230V

Level: 2nd cycle

Division code: LPB

Main field of study: UV1 Teknik

Syllabus valid from term: HT13

Introduction

Online and blended learning offers the opportunity to reshape classroom hours through web-based content deliver and interaction. It provides new opportunities for type of delivery, interaction, and facilitation of learning. But in order to use online and blended learning to enhance teaching processes, the ability to understand and apply appropriate pedagogical strategies is needed.

This course will cover both theory and the application of online and blended teaching strategies in higher education.

In the theoretical part of the course we will continue to use the model of Constructive Alignment introduced in previous courses. An additional theoretical framework for this course is the extensively researched theory of an online Community of Inquiry. The Community of Inquiry theoretical framework represents a process of creating a deep and meaningful (collaborative-constructivist) learning experience through the development of three interdependent elements - social, cognitive and teaching presence.

In the application part of the course you will design a module of online and/or blended learning. The module can preferably be implemented in a course or session in your own field. For the application part we will test and evaluate tools and techniques often used in online and blended education. The tools will be carefully chosen among KTH-supported and external tools to meet the theoretical framework and your own requirements.

This course itself is delivered in blended mode. This means that some activities in the course will be delivered face-to-face and some online. The course is 3 credits, which correspond to 80 hours workload.

Learning outcomes

The overall aim of this course is to provide you the opportunity to design and implement blended or online course components in higher education.

Concretely this means that you will be able to:

- Review, consider and critique principles of blended teaching in higher education.
- Examine teaching issues with other faculty and identify possible intervention strategies using ICTs.
- Integrate instructional theory and practice using ICTs in a way that is relevant and connected to your own discipline.
- Create and test a module where blended delivery strategies are used.

Course main content

The Community of Inquiry theoretical framework and its implementation to blended higher education. The ten principles of good practice in undergraduate education. Creating learning objectives for online and blended learning. Design, implementation and evaluation of online and blended learning activities. Test and evaluation of online and blended learning environments.

Eligibility

LH201V Learning and Teaching or an equivalent course.

Literature

Will be published at the start of the course.

Language of instruction

English only

Examination

INL1 - Assignment, 3 credits, grade scale: P, F.

To pass the course you need to attend all learning activities and make a design, implement it and evaluate the design, the implementation and the results. The project

itself and a reflective report on the process and the rationale for the design will also be assessed.

Course responsible

Martha Cleveland-Innes, Stefan Stenbom

Examiner

Stefan Hrastinski

Appendix B: Activities

Note: The course activities will be updated during the course

Date	Activity	Focus	Content material
10 days prior	Pre-reading	Introduction to course structure and content material	<ul style="list-style-type: none"> - Biggs Constructive Alignment review, https://www.youtube.com/watch?v=13VGZh6nhPc - Cleveland-Innes, M. & Garrison, D. R. (2011). Higher education and post-industrial society: New ideas about teaching, learning, and technology. In Moller, L., & Huett, J. (Eds.) The next generation of distance education: Unconstrained learning. New York: Springer. - Vaughen, N., Cleveland-Innes, M. & Garrison, R. (2013). Teaching in blended learning environments: Creating and sustaining communities of inquiry. Alberta, Canada: AU Press. (excerpt). - https://www.youtube.com/watch?v=aQYINN98Leg - https://www.youtube.com/watch?v=pyEQ3as-Q38
10 days prior	Review and post to course site		<ul style="list-style-type: none"> - http://www.forbes.com/sites/stevecooper/2013/04/25/what-does-that-meme-understanding-these-10-tech-buzzwords/
Week 1 starts Sept 2 w. 36	Face-to-face meeting (2 hours) Sept 2 between 10.00-12.00 am at Sydöstra galleriet KTH Biblioteket	Develop community, clarify objectives, discuss readings	<ul style="list-style-type: none"> - Keengwe, J., & Kidd, T. T. (2010). Towards best practices in online learning and teaching in higher education. Journal of Online Learning and Teaching, 6, 533-541. - Brinthaup, T. M., et al. "What the Best Online Teachers Should Do." The Journal of Online Teaching and Learning 7, no. 4(2011): 515-524. - https://www.youtube.com/watch?v=RafTc2Mxctk
	Review, and	Post questions	

Date	Activity	Focus	Content material
	post to, course site	and answers in discussion forum	
Week 2 starts Sept 9 w. 37	Face-to-face meeting (2 hours) Sept 9 between 10.00-12.00 am at Sydöstra galleriet KTH Biblioteket	Guest speakers from KTH VIDEO Discuss readings and plans for introducing technology into course designs	- Vaughen, N., Cleveland-Innes, M. & Garrison, R. (2013). Teaching in blended learning environments: Creating and sustaining communities of inquiry. Alberta, Canada: AU Press. (excerpt 2). - https://www.youtube.com/watch?v=fOZJvoVlzNQ
	Review, and post to, course site Discussions of Week 2 Technical pre-meeting in Adobe Connect (not mandatory) Sep 10 @ 5.00-6.00 pm and Sep 13 @ 3.00-4.00 pm.	Post discipline specific articles on online learning in individual subject areas Post questions and answers in discussion forum Refer to news stories and publications	

Date	Activity	Focus	Content material
	Guide (In Swedish) LINK to Connect		
Week 3 starts Sept 16 w. 38	AdobeConnect Session (1.5 hours) Sept 16 between 10.00-11.30 am LINK to Connect	Participant presentations of preliminary ideas regarding module creation	- Brown McCabe, D. & Meuter, M.L. (2011) A student view of technology in the classroom: does it enhance the seven principles of good practice in undergraduate education? Journal of Marketing Education Journal of Marketing Education-2011-McCabe-0273475311410847.pdf - https://www.youtube.com/watch?v=jx5DwEpyY8k
	Review, and post to, course site Discussions of Week 3	Discussion and examples of modules using content and technology	
Week 4 (two actual weeks) starts Sept 23 w. 39	Online forums	Enhanced activity in course site including audio clips and video clips by instructors Participant report on questions and progress Forum discussion on selected topics	

Date	Activity	Focus	Content material
	Review, and post to, course site Discussions of Week 4	As needed	
Week 5 starts Oct 7 w. 41	Face-to-face meeting (2 hours) Oct 7 between 10.00-12.00 am at Sydöstra galleriet KTH Biblioteket	Student presentations of learning modules Review of learning to date Objectives review – additions?	
	Review, and post to, course site Discussions of Week 5 About Final Assignment Due date of assignment text is Dec 3	Support for additional objectives Responses to learning modules	
Week 6 starts	AdobeConnect Session (2 hours) Dec 17 between 17.00-19.00 at Adobe Connect. LINK	Review of current trends in blended learning Discussion of future plans	

Date	Activity	Focus	Content material
	to Connect MCI back in Canada		
	Review, and post to, ongoing teaching and learning support site Discussions of Week 6	Create online community of practice to continue support post-course	- https://coi.athabascau.ca/