Experiences from Norway on implementing BIM in existing bachelor engineering curriculum

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ABSTRACT: This study explore experiences from ongoing implementation of BIM in existing bachelor engineering courses at Oslo Metropolitan University in Norway. This is done by a combination of semi-structured interview, net-based survey of management, lectures and students at the department. The findings are analysed by use of the multi-motive information systems continuance (MISC) model, which focus on hedonic, extrinsic and intrinsic motivation. This study do not confirm the traditional view that young students are positive and old teachers are negative to BIM, or that use of BIM will increase by itself when I become more mature. The most important aspects for increased implantation of BIM is to create a dynamic learning environment who support and combine all three types of motivation by having an intentional attitude to learning objectives, assessment criteria and context and relevance of competence. This approach can support implantation of BIM in all professional course in an engineering study as an integrated part of the learning outcome by focusing on “Use of BIM to learn Construction”.

1 INTRODUCTION TO THE CASE STUDY

Student love working with Building Information Model (BIM) based tools, and the Architects, Engineers, Contractors / Facility management (AEC/FM) industry demand BIM competency. However, implementation in higher architect and engineering education has been rather slow. This is a paradox since his type of professional educations has tradition for embedding the best industry practice into their curriculum. Lectures in higher education (HE) are also involved in research, and by this used to pay attention to latest trends and solution within their profession. Continuously development of own competency is embedded in the lectures way of working. It should therefore not be lack of awareness that explain lack of BIM in the curriculum in HE.

The challenge is therefore how to give the engineering students BIM-based competency, when the curriculum is packed with important professional content? A simple solution is of course to let the students work with authoring tools like Revit from Autodesk, ArchiCAD from Graphisoft, Vectorworks from Nemetschek or MicroStation from Bentley Systems in project work. This is a very practical approach to give the students skills in use of software, and a way to support teamwork. This approach imply that BIM is mostly used in courses where students work with design related projects in team. Training in use of BIM tools (software) is normally included in the course structure. The consequence is that BIM is restricted to a small number of courses using BIM tools, while all other courses continue in the “old way”.

This approach understands BIM as just software skills. This stands therefore in contradiction to both the need in the AEC/FM industry for increased BIM competency for future engineers and the impact of BIM as catalyst for new ways for working and collaborating to enable better solutions.

The research question is: What can be done to increase the implementation of BIM to support learning of construction engineering?

This study use the ongoing implementation at the construction engineering bachelor study program at Department of Civil Engineering and Energy Technology at Oslo Metropolitan University (OsloMet) in Norway as case. The intent to develop a “BIM-string”, see table 1 for overview, which embeds BIM as an integrated part of all engineering course in in the entire study program.

2 WHAT DOES THE LITERATURE SAYS

What is the status of BIM in HE? Is this problem already solved? A study by Badrinath et al. (2016) identified 70 academic BIM education publications. Of these, half were published in 2015, 71% of which were conference papers. Case studies and experiences
were the dominant type of publication in this type of studies.

There are challenges regarding BIM in terms of establishing (1) a common understanding of what BIM really is and (2) how to determine whether, to what extent, and for what purpose BIM is introduced in HE. The first challenge has been experienced by other scholars; for instance, in a study about BIM teaching strategies by Barison and Santos (2010, p. 1), the authors stated: “it is still unclear how BIM should be taught as most experiences are very recent.”. The NATSPEC survey (Ronney, 2015), however, did suggest increased interest in and a focus on BIM in a number of countries. According to Rooney (2014, p. 1): “It would appear that the majority of BIM education available to date focuses on training in the use of particular BIM software packages, particularly seen as a lot of training for professionals appears to be provided by the software vendors. Training for both graduates and professionals in openBIM concepts, BIM management and working in collaborative BIM environments appears to be still in its infancy”.

The Ph.D. thesis by Hjelseth (2015) introduce a dynamic understanding of BIM which combines the Model/Modelling / Managements do be applicable by focus on program / processes /person / as illustrated in figure 1.

![Figure 1. The trinity of BIM understanding (Hjelseth, 2015).](image)

The second challenge is based to the above referenced observations indicate that the dominant view of BIM is related to the use of software. HE is by nature theory focused, not on practical skills in the use of particular BIM software. Measuring the status of BIM in education must therefore include a better understanding of what BIM really is. Studies by Becker et al. (2011), Salman (2014), and Rooney (2014, 2016) demonstrate that many educational institutions across the globe investigates how to incorporate BIM in HE. Peterson (et al., 2011) give an example of how teaching construction project management with BIM support. This more integrated perspective is quite different from e.g. use of BIM software in project management to develop a 5-D schedule like Synchro based on import from authoring tool like Revit.

A study in UK by Underwood and Ayoade (2015) illustrate the situation in HE by following quote: “Despite an overwhelming level of support for the importance of BIM related accreditation criteria of courses in academic institutions, the level of conviction for actual change is however debatable”.

3 THEORETICAL LENS

Answering the research question can be answered just by asking direct question to the head of course. However, this will not give a reasoned answer. Introducing BIM in curriculum, and keep it as part require multiple actions – motivated by multiple aspects. This study introduce the “Multi-Motive Information Systems Continuance Model (MISC)” by Lowry, Gaskin & Mood (2015) to explore this situation. The “Intention to continue” focuses on three type of motivation: “hedonic, intrinsic and extrinsic”. All these three are included in each of the following perspectives: “Expectations”, “Disconfirmation” and “Performance” with respectively relation to “Attitude”, “Satisfaction” and “Attitude”. MISC can be arranged as quantitative study supported by regression analysis. This study is more explorative and we do therefore use a qualitative approach based on thematic analyses classify and analyse the three types of motivation in the MISC-framework.

4 BIM-STRING DIDACTICS

Implementing BIM in an overloaded curriculum need an adapted approach. Figure 2. illustrate an integrated approach proposed by Hjelseth (2017b). This integrated concept is based on The Technological Pedagogical Content Knowledge (TPACK) framework by Koehler (et al., 2014).

![Figure 2. The BIM methods related to the TPACK framework (Hjelseth, 2017b).](image)
The concept need to be applicable in the real context. Hjelseth (2017b) presents examples on how BIM tools and processes supports specification of relevant information (IDM) for use in e.g. structural calculation, use of model checking and information take off to give facts for cost calculations, or the develop an BIM execution plan to manage the information flow during the life cycle of the building project. Further details is included in the case description.

Implementation is supported by the “BIM-group”, three lectures who support practical implementation. They offer the course coordinator – and the students services like developing exercises, having introduction BIM lectures, and discussions / advices on how to implement. Implementation has been discussed with all relevant course coordinators, and solutions are developed for 1st and 2nd semester.

5 CASE DESCRIPTION

5.1 Overview of the BIM-string

This study is based on the ongoing implementation in the bachelor study in construction engineering at OsloMet in Norway. This is a traditional engineering study in compliance with the national framework. Table 1 illustrate professional engineering course relevant for embedding BIM as integrated part of the curriculum and defined learning objectives.

Table 1. Overview of courses in the BIM-string

<table>
<thead>
<tr>
<th>Semester: Course, ECTS</th>
<th>Software</th>
<th>Process</th>
</tr>
</thead>
<tbody>
<tr>
<td>1: Introduction to Building Professions, 10</td>
<td>J Revit</td>
<td>bSDM</td>
</tr>
<tr>
<td>2: Building Technology, 10</td>
<td>J Revit</td>
<td>bSP</td>
</tr>
<tr>
<td>3: Building Materials and Concrete Design, 10</td>
<td>J Robot</td>
<td>bSDD</td>
</tr>
<tr>
<td>4: Technology management, 10</td>
<td>J Process Modeller</td>
<td>bSP, BEP</td>
</tr>
<tr>
<td>5: Design of Steel- and Timber Structures S), 10</td>
<td>S Robot</td>
<td>bSDM</td>
</tr>
<tr>
<td>5: Land Use and Transport Planning P), 10</td>
<td>P Novapoint</td>
<td>bSDM</td>
</tr>
<tr>
<td>5: Elective BIM course, 10 #)</td>
<td>J Revit, Nova-point, Solibri</td>
<td>All</td>
</tr>
<tr>
<td>6: The Building Process, 10</td>
<td>J Process Modeller</td>
<td>bSP, BEP</td>
</tr>
<tr>
<td>6: Bachelor thesis, 20</td>
<td>J All</td>
<td>All</td>
</tr>
</tbody>
</table>

ECTS, 30 = 100% work load of one semester
J: joint for both study specialisations
S: study with specialisation in structural engineering
P: study with specialisation in infrastructure planning
#: proposal, not approved by the department management
bSDM – buildingSMART DataModel (IFC) - interoperability
bSP – buildingSMART Process (IDM) – Collaboration
bSDD – buildingSMART DataDictionary (IFD) – Product/Material data
BEP – BIM Execution Plan – Collaboration / Management
All – combination of all above + others
(OsloMet – Engineering study, 2018)

The curriculum is, as for these types studies, overbooked with professional content; lectures, exercises, projects and exams. Use of software like Revit and Robot has been used in students’ projects for a long time. Systematic implementation called the “BIM-string” started with first year students (FYS) autumn 2017. Use of BIM software in the string is not an add-on is each course, but a tool to support the learning objectives in each course. However, use of BIM and has a long and unsystematic history: We have therefor include last year students (LYS) as part of the study.

5.2 Status of implementation

The systematic implementation of the BIM-string (BIM in BE) started autumn 2017 BIM as use or Revit software is embedded in 1st semester course in “Introduction to Building Professions”. In first semester, all students work in teams of five, have different roles; architect, structural engineer, building engineer, contractor etc. The teachers has written a course book. This include a chapter (25 pages) about “Information management”, which is place before the major part about Revit training (135 pages). This illustrate that the focus on BIM is not just to learn Revit to design a building, but to be aware of the different need for information in each roles throughs the entire life cycle of the building.

In 2nd semester does the course “Building Technology” following up the BIM sting by focus on material properties – and how this information can be entered, processed, presented and distributed in BIM. This is done by a separate lecture, an exercise manual and hand-in of a small report. An interesting perspective is that the course coordinator has projects in the industry: He is rather critical to the quality of BIM models used as support for production and document building details. However, this is actually a good foundation for the need for improving the quality of what the BIM software “deliver”. This include both need for relevant details (Level of Development) and content of product documentation (Level of Information). The role model is the “Critical engineer”, which require knowledge about good professional (technical) – and document this by use of BIM tools.

The “BIM-string” is continued in 3rd semester in the “Building Materials and Concrete Design” course. This will continue the approach from 2nd semester with increased focus on quality of profession facts/information. The 4th semester will in the “Technology management” course give priority to processes and new way of working. In last year, 5th and 6th semester, of the bachelor study will the professional courses intent to combine BIM as “Product and process modelling”. An elaborative course for specialisation in BIM has been proposed by the BIM research group, but have so far not been supported by the management. In the 6th semester can the “The
6 METHODS

This study done by a combination of a net-based survey to all students in first and last year of the bachelor study in construction engineering. The course coordinators (responsible teachers) for the engineering courses listed in table 1 participated in semi-structured interview. The findings was analysed by use of the MISC framework.

The net-based survey included all (approx. 150) first year students (FYS). We got feedback from 43 students (30%). The have experiencer from two course in the “BIM-sting”. The survey included all (approx. 120) last year students (LYS), where we got feedback for 47 student (40%). The have experience from use of BIM based software (like Revit, Robot, Solibri, Novapoint) in variable degree in several engineering courses, see also table 1. The answers is rounded to nearest 5 % to avoid too strict interpretation of small differences on limited answering basis.

This study included also semi-structured interviews with course coordinators (responsible teachers) for the engineering courses listed in table 1. The teachers at the department was well informed about the potential of BIM in the industry. All teachers was informed and aware of the industry focus on BIM in general. However, most teachers did not find BIM relevant for his or her own courses. The general experience was that BIM was already included in the “Introduction to Building Professions” course in 1st semester, and limited need for continuing with BIM.

The management group at the department shared the same attitude as the teachers. They was aware of the high interest for BIM in the industry, but do not want to give recommendation to implement. They delegated this decision has by each teacher individually. The other attitude was that BIM most include extra cost, or change in lecturing coordination.

7 RESULTS

7.1 Interpretation of feedback from students and teachers

This study is use MISC as framework for structuring the results into: hedonic, intrinsic and extrinsic motivation. Analysis based on MISC has “Intention to use” as final outcome. In our respect is related to in which extent integration of BIM into existing curriculum has support to be continued. The results was grouped into “Students” and “Teacher” finding, which then is extracted into a joint result.

7.2 Feedback from the net-based survey to the students

The first section of the questionnaire was related to Digitization / use of BIM in the construction industry. On the question “To what extent do you think digitalization / BIM will change the construction industry for the next 3-5 years?” chosen 15% of first year students (FYS) and 50% of last year students (LYS) the: “In very high extent” as answering option.

Regarding the feedback on the question “To what extent do you think digitalization / BIM will change your way of working when you get out of work?” reported 10% of (FYS) and 40% of (LYS) “In very high extent”. On the question ” To what extent do you think digitalization / BIM will change your way of working when you get out of work?” 15% of first year students (FYS) and 60% of last year students (LYS) “In very high extent”. The feedback from LYS is reflecting the interest in the industry. Approx. 2 of 3 had been to interview for job. Of these answered 3 of 4 that they had been asked about digital competency. One LYS commented in the net-based survey that he did not get the job due to limited BIM competency. More student commented that the industry was focused on BIM, and that OsloMet should increase focus on BIM in the curriculum.

On the other side: 3 of 5 student did also ask the industry about their plans for digitalisation when they was at job interview.

7.3 Experiences with software training at OsloMet

To what extent do you think that what you learned about Revit will be useful in engineering studies?

There was a high correlation feedback between the expectation from FYS, and the experience form LYS, Approx. 15% reported “In very high extent”.

However, on the two last answering options: (Limited and little extent) had no answers from FYS, while 15% of LYS used these answering options.

There was limited comments from FYS. These commented that teamwork was relatively time consuming compared to working individual.

The comment from LYS was as expected more extensive, and the questionnaire for LYS was there extended with additional questions: “Focus in the course was on generating a 3D model in BIM, and not in exploiting the information in BIM”. Another commented following: “We have also not learned about Solibri”, while another said that “BIM should be regarded as a process. One student commentes with other courses: «In math, we are encouraged to program in Matlab, that's good. But then we have fed and revised the construction of ALL subjects for three years. Then I get a small extent in the scale of use».”
7.4 Factors contributing to motivation

The feedback on question: “What have been the most motivating working with BIM / Digital model?” is presented in table 2. below.

Table 2. Overview factors motivating for BIM use

<table>
<thead>
<tr>
<th>Answering option</th>
<th>LYS</th>
<th>FYS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fun to create yourself:</td>
<td>70%</td>
<td>65%</td>
</tr>
<tr>
<td>Easier to get good results:</td>
<td>0%</td>
<td>25%</td>
</tr>
<tr>
<td>Less job when working in group:</td>
<td>15%</td>
<td>0%</td>
</tr>
<tr>
<td>Do not know / else:</td>
<td>10%</td>
<td>10%</td>
</tr>
</tbody>
</table>

The answers on “Fun to create yourself” can be interpreted as intrinsic motivation is the dominating. On the answering option “Easier to get good results” was there some difference between FYS and LYS. 8%. The difference indicate extrinsic motivation is relatively low and become increased during the st by when awareness of industry demand become clearer. On “Less job when working in group” the answering difference indicate clear differences in hedonic motivation. The grade itself as motivation decrease during the study.

The questionnaire followed up with an open text answer on the question: “What do you think are the main reasons you want to work more digital / BIM?”

We got comments was only from LYS:

“Has worked a lot of paper drawings as craftsman in the past: A massive advantage with BIM is that you get a lot easier on building / items. It is also much easier to convey ideas and thoughts in 3D than 2D”. This comment highlight the role of statements form the industry to (extrinsic) motivation.

Following comment focus on the importance in lack of intrinsic motivation. “Seems it was a joke when it came to something, but generally not motivating to work because we do not learn that very well. Along the way, we have received very little info about how much digital tools are actually used, and it’s hard to see the importance of learning this”.

Other comments mentioned the importance from the industry: “Think it will be standard to use in the industry.” / “Will acquire knowledge in order to do a better job.” / “Think it will make the industry more efficient and help make it more environmentally friendly.” / “All big companies use it, it should be more focused on learning how to use it in the study so that you are more prepared for working life.” / “BIM is the future, it is needed at work.” / “Learn how they do this out in the industry.” / “Learn to facilitate the work is done with this type of tools.” / “Work more with the information in the BIM and use this for cost estimates e.g. LCC, FDV, etc.” / “This is the present and future of the construction industry.”

This imply that intrinsic motivation is dominating by both FYS and LYS. The importance of extrinsic motivation is mostly connected to impact of this type of competence can have for getting a job. This correspond with an understating of a good engineering education is not only good grades, but competency which is relevant for the industry. BIM/digitalisation can act as a marker for OsloMet as the future oriented engineering education study.

7.5 Factors contributing to demotivation

The feedback on question: “What have been the most de-motivating working with BIM / Digital model?” is presented in table 3. below.

Table 3. Overview factors demotivating for BIM use

<table>
<thead>
<tr>
<th>Answering option</th>
<th>LYS</th>
<th>FYS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nothing:</td>
<td>5%</td>
<td>20%</td>
</tr>
<tr>
<td>Difficult to use Revit:</td>
<td>30%</td>
<td>10%</td>
</tr>
<tr>
<td>Much job in relation to learning:</td>
<td>15%</td>
<td>25%</td>
</tr>
<tr>
<td>Much job in relation to grade:</td>
<td>40%</td>
<td>30%</td>
</tr>
<tr>
<td>Do not know / else:</td>
<td>10%</td>
<td>20%</td>
</tr>
</tbody>
</table>

The intention with this question was to identify if elements that reduced the motivation and priority to increased use or BIM/digitalisation in both learning, teaching and assessment process.

The questionnaire followed up with an open text answer about the question: “What do you think are the main reasons you want to work more digital / BIM?”

We the comments was also only from LYS:

“IT takes some time to get into. I think it took some time before you saw the results. It was also a bit de-motivating every time you got an error, because since it is at a beginner level, you have no skills other than following the course / template / recipe.”

“We have used BIM as a tool in project assignments, but this has not been a work requirement, so it does not matter to the grade.”

“Lack of continuity. Learned a lot of first semester in constructional introduction. A little used in the teaching after that, and a half-hearted attempt to implement it in the plumbing field.”

“Feeling this question is not in place. All businesses focus on BIM, this is the industry students are going into. When people saw about using BIM, it is because they are generally tired of the studies and are going to find something to blame on. It’s not hard to use when you follow and make compulsory. There is much work in relation to the learning (intuitive), much work in relation to character. What can be demotivating is for the Educational Introduction that one must "play" all the roles instead of having one who represents the line, cover all the fields of responsibility, while focusing on BIM. Then there can be a lot and people can be demotivated.”
7.6 Increased use in the engineering study

The experience from LYS is an important indicator of the potential for increased digitalisation in existing curriculum (FYS is part or the new “BIM-string” and was therefore not asked).

Over 85% of the LYS chosen the answering options “To a very large or large extent” on the question: “To what extent do you think it is possible to take more use of professional software in the teaching of engineering education?” This positive interest for something relatively unknown indicate that the motivation probably is based on intrinsic motivation for learning more or learn in a different was. In addition can increased awareness of the demand in the industry for this competence trigger extrinsic motivation. Some selected feedback in the open text field was: “Increased learning by user of BIM tools.” / “Use it in several courses, not just the first year as we experienced.” / “Important to use the programs over time so you remember how to use it.” / “It is time consuming to get into these programs, and this should not be at the expense of important engineering such as constructional, steel and wood constructions, etc.” / “The basic knowledge in engineering MUST be good: Shit in, shit out.” / “The tasks in the 1st semester can be done with more focus on digital work than paper work. Drawings have previously been handed in largely on paper - switched to digital reinforcement drawings, etc. Exercises in other subjects may be done slightly less regarding handwritten, but with more focus on how software can be used to solve. One might also use programs in a larger part of the classroom, to show, for example, how different forces work on constructions.” / “In the structural engineering courses we have dimensioned, we could use Robot and Revit more accurately and dimensioned in the programs, and supplemented to hand calculation the see the information use in the formula and standards.” / “Learning a lot, but not always as easy and understanding everything that the software does. For example, for curvature for roads by use of Novapoint Trimble software.” / “This will be needed in all jobs in the future.” / “One feels more ready for work.”

7.7 Students PC situation

The survey include a question about to see if the teaching in increased degree could be based on students own PCs, see table 4.

<table>
<thead>
<tr>
<th>Type of computer</th>
<th>FYS</th>
<th>LYS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Laptop PC</td>
<td>75%</td>
<td>40%</td>
</tr>
<tr>
<td>Portable Gaming PC</td>
<td>15%</td>
<td>10%</td>
</tr>
<tr>
<td>Portable Mac</td>
<td>10%</td>
<td>50%</td>
</tr>
<tr>
<td>Does not have own computer</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Desktop Gaming PC</td>
<td>30%</td>
<td>10%</td>
</tr>
</tbody>
</table>

An interesting observations that FYS have more Gaming PC than LYS. This indicate that they invest more in PC, and use it for more advanced tasks with high quality visualisation. Another observation it that LYS have very high extent of Mac. This is interesting, since Mac cost more that PC, and do normally create problems for most BIM- / engineering software. This indicate that the students do not experience in use of professional software, and therefore can choose Mac as preferred laptop for “office” work.

Asking the student about willingness to invest e.g. 1.500 € in a gaming laptop. Approx. 30% of FYS and 45% LYS was positive to invest. Many students also claimed their own PC/Mac was good enough. In the open text was FYS was negative, while some of the LYS argument for the benefit for investing in high performance computer equipment. This feedback indicate that one can go for flexible solution for software training on students PC – if the students are informed about the requirements – and that the PCs actually become used regularly in the courses. However, this is not the case today.

7.8 Teachers point of view:

The teachers are all very well aware of the focus of BIM in the industry, and are general positive to include BIM in the study program. However, not in mine course, it is already too packed. The main focus of the teachers is to give good courses in their own subject. This imply focus is on teaching the students as much as possible, and to introduce advanced methods. This “silo” situation no unique of the case study. This situation has been the main motivation for inventing a new integrated approach to implement BIM in existing curriculum

The course coordinator faces two challenges when introducing BIM in an existing professional course: What to do in a professional aspect, and how to do it in a pedagogical aspect. This imply that project based courses are more likely candidate than lecture based courses. The approach in the “BIM-sting” is to support leaning of existing learning objectives in the curriculum by use of BIM-based tools and new was of learning and collaborating.

However, letting the course coordinator answering this question alone is maybe not polite. The BIM-group does in this respect play an important role to support practical implementation adapted to each course. This is a learning processes for all, based on dialogue and establishing a joint understanding. When the course coordinator see that this is also supported (demanded) by the students, this contributes to increase their extrinsic motivation for course evaluation, and maybe more important, trigger intrinsic motivation for felling development in own lecturing. This is not “proven”, but course coordinators and lectures wants to increase integration of BIM support in their courses.
7.9 Support from the department management

The dominating view in the department management is that BIM is interesting and relevant. Changing existing curriculum with existing staff is in general a hard challenge. It is the course coordinator which has the mandate to change an approved course curriculum. (The changes must in next step be approved by the Board of education).

The “BIM-string” is supported as a way to motivate course coordinators to include BIM and digital way of working in their lecturing. However, the department management has not stated in meeting or other statements encouraged including the BIM-string is important, or asked for report of ongoing progress. Implementing is supported if this does not include increased costs, can be done with existing structure, the responsible teacher give full support (no encouragement to change), and very important or if existing part of curriculum do not become reduced. The priority is given to the “hard” engineering topics like structural calculations, and difficult topics they have to learn at school. BIM is a “soft topic”, which the students will learn when the go into job.

However, digitalisation has in last years been given priority at strategic level by the university management. When the budget situation for current year is improved, the department management is supporting investment in a “BigRoom” with interactive white board (smart board screens) and VR-equipment. This imply that funding of investment in equipment and study facilities is supported, but changes in didactic and curriculum is not given attention. This attitude has allowed the BIM-group at the department to act dynamically, based on intrinsic motivation, to implement the “BIM-string”.

8 DISCUSSIONS

8.1 Motivation and management of change

This study identify that both students and teachers are driven by different types of motivation in different contexts and learning environments. Awareness of the impact of which types of motivations different learning environments support is most critical.

This study have not identified simple relations the like young students are positive and old teachers are negative to BIM as arguments for level of BIM use. The study have not identified relations like BIM will be used more in HE when it becomes more common in the AEC industry the industry.

There has been hard to find similar studies in use of BIM in HE. Most examples of studies is based on experience by use of BIM-based software to design as specified solution. The outcome has been assed on the quality of the designed solution, which in most cases is based on visualisation, and not the content of information in the BIM. Most studies of BIM is in HE has focus on use of BIM software to design. This design can be rather advanced, and is then often performed by teams. It has therefor been hard to find relevant studies to include in this discussion.

A study by Lassen et al. (2017) do also confirm the importance on intrinsic motivation explaining why student invested much time in the pass/fail assessed project task in the first semester course “Introduction to Building Professions” at OsloMet.

8.2 Relevance of digitalisation for HE

Numerous presentations state clearly that BIM is an abbreviation for building information modelling, and where modelling indicates that BIM is about processes, it is a new way of working and collaborating. These types of presentations have received recognizing nods and applause. “BIM is a process that’s enabled by technology. You can’t buy it in a box, it’s not a software solution, and it’s something you can’t do in isolation” (Mordue et al. 2015, p. 349).

A study by Hjelseth (2017a) show that there is wide variation in understanding of what BIM is, and where the dominating underrating is use of software tools (programs), not focus on processes when becoming introduced to BIM/digitalisation, as illustrated in figure 3.

Figure 3. Shift of focus in BIM understanding during the engineering study

However, learning software, and especially maintain this competency is not the scope of HE. The feedback from first year’s students did not give significant support for introduction of BIM to support focus on processes. The attitude was more related to use BIM to produce something that can be delivered. The students are in general very positive to use BIM based tool, but there is challenge that it take a relative high amount of study hours compared to the impact on the grade of the course. This approach do also contribute with limited learning outcome in first phase as illustrated in figure 4.

Figure 4. Return of investment in software training in engineering curriculum
8.3 Need for deeper understanding

Norway do not have a defined and clearly expresses BIM strategy to support investment in competency. The BIM strategy at OsloMet can be regarded to aim at Level 3 in the UK wedge for BIM strategy (McPartland, 2018). However, the origin of OsloMet strategy was not to aim for a pre-defined level, but to support engineering education by introduction of technology that support increased understanding of working as engineer.

There is a difference between having success with BIM/digitalisation in a single dedicated course, versus integration into a curriculum with focus on engineering competency.

9 CONCLUSION REMARKS

Implementing BIM in the curriculum in HE is a complex task with multiple aspects when one give priority to learning of professional competency and not only use of software to solve a project task. The presented case from OsloMet to not give a fixed answer, but outline an applicable concept for integration of BIM in professional engineering courses. Focus is given to BIM as process for providing, processing and presenting information (facts) to support professional tasks as engineer (student).

This study identify the importance for combining learning activities (project task, exercises, lectures, software training, industry contribution etc. which trigger multiple motivations; hedonic, extrinsic and intrinsic, as an important factor for continuously implementation and improvements through the entire study program.

The integrated approach can support implantation of BIM in all professional course in engineering studies when it becomes part of the learning outcome by “Use of BIM to learn Construction”.

10 REFERENCES


