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LEARNING AND TEACHING WITH TECHNOLOGY IN HIGHER EDUCATION

– a systematic review

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CONTENT

SUMMARY

This systematic review was commissioned by the Norwegian Ministry of Education and Research and answers the following research question: *How can teaching with technology support student active learning in higher education?* The systematic review was conducted in collaboration with SLATE (Centre for the Science of Learning & Technology) and has explored how technology is influencing educational practices in higher education institutions.

The systematic review has 5 chapters. Chapter 1, *Introduction*, presents strategies and policy initiatives for digitalisation of Norwegian higher education. As a result of an increasingly diverse student population and the expected exponential growth of demand for education provision, higher education institutions currently face major changes. The Norwegian Ministry of Education and Research has recently taken several initiatives to promote technology use in higher education institutions, both on infrastructure, and related to teaching and learning. The eCampus-programme was initiated to provide accessible and robust ICT solutions and to support the pedagogical use of technology. In 2013, the MOOCs commission was appointed to investigate opportunities and challenges arising from the emergence of Massive Open Online Courses and similar offers. The commission reported a series of recommendations, including a targeted fund, the development of a national MOOC platform, digital competence development for teachers, and increased use of open educational resources.

A systematic mapping of the effects of ICT on learning outcome[1] showed that it is *how* digital tools are implemented and used pedagogically that matter for students' learning outcome, not the technology itself.

This finding is confirmed in two recent reports from NIFU [2, 3]. Having found that students self-organise a scaffolding peer support system to compensate for insufficient interaction with teachers, a study of the first international MOOC developed at the University of Oslo, concludes that new pedagogical practices appears to be *in the making* for online learning. This indicates that digital technologies must be integrated into course designs and their use facilitated by teachers[4] because it is not the digital technologies *per se* that solve teaching and learning challenges.

The *Status report on Norwegian higher education*[5] showed that higher education institutions are not fully exploiting the possibilities in digital technology. Norwegian students reported that they only to a small degree experienced pedagogical use of digital technology in their education. This problem is not exclusive to Norway. The EU Commission[6] argues that member states should be supported in developing national frameworks and infrastructure for integrating new modes of learning and teaching across the higher education system. Across OECD-countries, the expectation is that digital technologies and pedagogy should be integral to higher education institutions' strategies for teaching and learning, and in parallel, a competency framework for teachers' digital skills must be developed.

1 Morgan, K., Morgan, M., Johansson, L. & Ruud, E. (2016) *A systematic mapping of the effects of ICT on learning outcomes*. Oslo. Knowledge Centre for Education. www.kunnskapssenter.no

2 Damşa, C., de Lange, T., Elken, M., Esterhazy, R., Fossland, T., Frølich, N., ... & Stensaker, B. (2015). *Quality in Norwegian higher education: A review of research on aspects affecting student learning*. 2015: 24

3 Nerland, M., & Prøitz, T. S. (2018). *Pathways to quality in higher education: Case studies of educational practices in eight courses*. NIFU report 2018:3

4 Henderson, M., Selwyn, N., & Aston, R. (2017). What works and why? Student perceptions of 'useful'digital technology in university teaching and learning. *Studies in Higher Education*, *42*(8), 1567-1579.

5 Tilstandsrapport for høyere utdanning 2018 https://www.regjeringen.no/no/dokumenter/tilstandsrapport-for-hoyere-utdanning-2018/id2600317/

6 European Commission (2014) Report to the EU Commission on New modes of learning and teaching in higher education http://ec.europa.eu/dgs/education_culture/repository/education/library/reports/modernisation-universities_en.pdf

Chapter 2 describes the systematic review method. Electronic searches for studies published between 2012 and 2018 were conducted in seven databases September 2017 and January 2018. Additional supplementary and hand searches were conducted, and the process yielded 6526 hits. Due to the large number of papers, text mining technology was used to assist the identification of relevant studies. After the first stage of relevance assessment, 71 studies with potential relevance for the systematic review were identified and read in full text. 35 studies with high or medium quality and relevance are included in the systematic review. A configurative synthesis suitable for analysing findings from heterogeneous studies has been conducted.

Chapter 3 presents the 35 included studies, in five subchapters. 3.1: *Institutional level and decision making*, presents five studies with findings of particular relevance for higher education leaders and administrators. These studies cover themes such as learning analytics (LA), learning design and MOOCs and provide information about big data, knowledge utilisation, evaluation and big-scale initiatives that require leaders' attention, funding and institution wide training and support to reach the potentials inherent in new technologies. The studies show the need for institutions to establish systems for continuous learning, where data gathered is systematically transformed into action-relevant knowledge that can be used to design learning environments better adapted to students' individual and social needs. Successful learning designs support student active learning by allowing them to communicate, produce, experiment, interact and engage in varied forms of assessment. Learning Analytics has the potential to support this work through providing useful big and small data.

In 3.2: *Learning and teaching across contexts*, ten studies with relevance for department heads, lecturers and students are presented. An underlying assumption in the studies is that teaching can no longer be the sole responsibility of individual teachers. Having investigated the potential educational benefits of a combination of capture technologies (recorded lectures) and a variety of traditional classroom practices across digital and physical learning contexts, studies report inconsistent findings. While researchers perceive capture technologies as a potentially productive learning design, research cannot establish positive outcomes. A behaviourist learning paradigm, where instruction is perceived as content delivery, seems to dominate higher education teaching practices, even when teachers use capture technologies. Researchers report that both teachers and students are challenged when learning happens across formats. Blended and hybrid learning requires increased time commitment from teachers, and students are expected to develop skills in goal setting, monitoring, time management and self-evaluation, in addition to a range of self-regulation strategies. In the studies included in this category, the need for institutional and technical support for staff is a major issue.

In 3.3: *Emerging educational technologies and innovative learning*, ten studies investigate the potential of emerging technologies and what is required of institutions in terms of facilities, organisation and staff development for these innovations to impact the institutions' teaching practice. It is argued that institutions must develop policies for how they want to educate young technology users. Augmented Reality is a promising emerging technology with educational potential as it projects digital materials onto real-world objects, enhances and expands students' learning experiences and facilitates collaboration and student active learning. The included studies show that emerging technologies, such as games, must be goal directed, competitive, and designed within a framework of choices and feedback to enable teachers and students to monitor learning progress. Playing and designing games can contribute to active, engaging, and authentic educational experiences. Introducing new technology does not, in itself, guarantee innovative practices in higher education institutions. Instead of taking the opportunity to introduce student active teaching methods, staff tends to adapt new technologies to traditional practice. The dichotomy digital/non-digital should not overshadow the fact that *pedagogical quality* is the most important issue in both face-to-face and technology supported educational provision.

In 3.4: *Collaborative learning*, five studies are presented. There are indications in the research that when students work in groups, responsibility tends to be dispersed. This highlights the need for learning designs that support collaboration and activate each student. Students in higher education are expected to learn to argue. In academically productive talk (APT), students build on prior knowledge and connect their contributions to domain concepts to support their claims and arguments. Encouraging students to make their knowledge sources explicit is considered vital in academic environments. Studies also find that student collaboration happens more spontaneously in apps designed for social media use than in more formal learning technologies. Depending on the design, Wikis are perceived as a favourable tool to support collaborative learning. A review of research on telecollaboration reveals traditional online practices with email dominating the communication. Researchers also ask why academics don't recognise their own responsibility for professional development in the area of technology use in teaching, but expect external initiatives.

In 3.5: *Barriers to technology use and innovative teaching*, five studies are presented. The studies show that there are significant barriers to technology use in higher education institutions. One paradox identified is that academics appear not to be using a *scholarly approach* when implementing technology in education. Research indicates that pedagogy is a more fundamental barrier to innovative teaching in higher education than technology use. Therefore, the conclusion in all five studies is the obvious need to ensure that the focus of staff development programs in higher education is on instructors' perception of teaching *first*, and then on technology. Knowing how to use technology is important, but not sufficient, if the institutional goal is student active learning.

Chapter 4 presents the configurative synthesis. The included studies reveal a consistent pattern: while researchers assume the transforming potential of technology, studies find few examples of sustainable innovative teaching practices in higher education. The overall picture is that traditional ideas about how students learn still dominate and that instead of challenging the tradition, technological devices are adapted to the tradition. Technology is a tool with the potential to transform teaching and learning, facilitate collaboration and communication across contexts, and support student active learning. However, this potential is not realized unless teachers and staff use technology in a pedagogically appropriate manner. Researchers suggest that teachers abandon a behaviouristic perspective on learning and adopt a socio-cultural, constructivist approach. This requires that institutions prioritise professional development. Institutions should take the initiative to develop *scholarly* teachers who are research-informed, inquire into their own professional learning opportunities, and disseminate their findings. The status of teaching must be heightened, the knowledge base for teaching strengthened and an infrastructure developed for continuous inquiry into questions of importance for pedagogy and didactics.

Chapter 5 concludes and lists knowledge gaps in the research on the use of technology in higher education identified in this review.

1 INTRODUCTION

This systematic review is commissioned by the Norwegian Ministry of Education and Research and conducted in collaboration with SLATE (Centre for the Science of Learning & Technology)[7]. It answers the following research question:

> *How can teaching with technology support student active learning in higher education?*

Digitalisation influences and challenges how education is organised and administered. The worldwide demand for higher education provision is expected to grow exponentially, and over the next 10 years, e-learning is projected to grow fifteen-fold, accounting for 30% of all educational provision[8]. The competition between higher education institutions increases when well-reputed institutions, such as Harvard, Stanford and the Massachusetts Institute of Technology (MIT), provide free MOOCs. At the same time, this opens for new opportunities[9]. The Norwegian Government expect leaders and managers in higher education to focus both on how technology can contribute to a more efficient and robust sector, and how it can be used to renew practices and enhance educational quality.

7 The Norwegian Knowledge Centre particularly thanks Professor Barbara Wasson for valuable input at seminars, and comments on drafts. PhD-candidate Kamila Misiejuk (SLATE) has read articles and contributed to seminars. Professor Konrad Morgan has read and commented on drafts, read articles and participated in seminars. Researcher Tamara Kalandadze has read articles and contributed at the early stages of the review.

8 European Commission (2014). *Report to the EU Commission on New modes of learning and teaching in higher education* http://ec.europa.eu/dgs/education_culture/repository/education/library/reports/modernisation-universities_en.pdf

9 Meld. St. 18 (2014-2015). *Konsentrasjon for kvalitet — Strukturreform i universitets- og høyskolesektoren* https://www.regjeringen.no/no/dokumenter/meld.-st.-18-2014-2015/id2402377/

Following up the White Paper *Culture for Quality in Higher Education*[10], the Norwegian Ministry of Education and Research has developed a strategy for digitalisation of higher education (2017-2021)[11]. As digitalisation and new platforms take a more prominent place in the sector, Information and Communication Technology (ICT)-solutions impact the quality of education and research. The use of learning analytics to understand students' learning patterns and improve learning processes, is still in its infancy[12], but is expected to assist institutions in reaching the goal of improving student learning, broadly facilitate study options, and support outstanding research. The interactive use of technology for knowledge development must be elevated to a strategic level at higher education institutions and integrated into all academic and administrative activities. How technology is developed and used must therefore be an integral part of national and institutional strategies.

The Norwegian higher education sector is at the forefront of co-operation on digital solutions, with effective infrastructure solutions and joint services for administrative tasks, education, and research. Nevertheless, there is significant potential for quality improvement by exploiting existing and new ICT solutions, and these aims are outlined for *data and infrastructure, students* and *teachers*:

10 Meld. St. 16 (2016–2017). *Kultur for kvalitet i høyere utdanning* https://www.regjeringen.no/no/dokumenter/meld.-st.-16-20162017/id2536007/

11 https://www.regjeringen.no/no/dokumenter/digitaliseringsstrategi-for-universitets--og-hoyskolesektoren---/id2571085/

12 The MOOC Committee's proposal to establish an environment for research-based knowledge development, development work, and knowledge-sharing related to learning analysis was followed up through the establishment of the Centre for the Science of Learning & Technology (SLATE) in 2016 by the Norwegian Ministry of Education and Research with the University of Bergen as the host institution.

Aims for data and infrastructure: Data is stored once and made available from a single source. Data is retrievable, available, interoperable, and reusable in accordance with the FAIR principles. Infrastructure is flexible and facilitates mobility and development. Cohesive governance and management of information security are fundamental to digitalisation and strategic efforts.

Aims for students: Students have access to a modern and flexible learning environment that facilitates individual and collaborative learning. They participate in an academic community where technology is integrated in active and varied methods for teaching and assessment, and provide students with advanced academic and digital qualifications. When participating in research projects (research-based teaching), students learn principles and practices of research.

Aims for teachers: Teachers have high levels of digital and pedagogical skills, incentives for the development of their own teaching, access to support services and collegial communities. They are familiar with a wide range of applications, digital tools and services that support teaching, from planning, through interaction with students and colleagues, to the follow-up and evaluation of students at individual and group level. Based on documented results, teachers can be remunerated or given time to further innovate their pedagogical practice.

1.1 POLICY INITIATIVES

In recent years, the Norwegian Ministry for Education and Research has taken several initiatives related to digitalisation in higher education institutions; both on questions of technology and infrastructure, as well as changes in teaching and student active learning.

In White Paper no. 18 (2012-2013) *Long-term perspectives – knowledge provides opportunity*[13], the Government calls for a strengthened effort regarding high-quality higher education, free access to learning resources along with relevant competence and skills development, by establishing the five-year and NOK 70 million eCampus program. ICT-supported flexible education ensures equal access to higher education, and institutions are expected to cooperate on the flexible use of professional resources and technological solutions. Digital learning resources can lower the thresholds to higher education, by facilitating access, independent of geography, age and other factors. When evaluating the eCampus program,[14] NIFU[15] found that the program has succeeded in providing accessible and robust ICT solutions and have promoted the use of ICT based tools. However, the use of ICT tools varies across different institutions.

In June 2013, a Commission[16] was appointed by the Norwegian Government to investigate the opportunities and challenges arising from the emergence of Massive Open Online Courses (MOOCs) and similar offers. The Commission should map the development of MOOCs and provide recommendations on how Norwegian authorities and institutions should relate to technological developments. The report showed that MOOCs were not central to the strategic planning of Norwegian universities and colleges and not perceived as tools for pedagogical development. A traditional, instruction-based model for online education seemed to be the most widely used. The Norwegian Commission on MOOCs reported a series of recommendations including a targeted fund, the development of a national MOOC platform, digital competence development for teachers, and more use of open educational resources. Studies[17] on digitalisation at Norwegian higher education institutions indicate that digital innovations are not necessarily anchored in institutional strategies, but driven by individual enthusiasts. Studies also indicate that newly trained teachers lack the sufficient digital skills[18], also confirmed by the MOOC Committee[19]. Several institutions have developed MOOCs with support from the Norwegian Agency for Digital Learning in Higher Education. New digital assessment

13 Meld. St. 18 (2012–2013), Lange linjer – kunnskap gir muligheter https://www.regjeringen.no/no/dokumenter/meld-st-18-20122013/id716040/

14 Tømte, C., Aanstad, S., og Løver, N. (2016) Evaluering av eCampus-programmet, NIFU rapport 2016:44

15 Nordic Institute for Studies in Innovation, Research and Education

16 NOU 2014: 5 MOOC til Norge. Nye digitale læringsformer i høyere utdanning

17 Norwegian Agency for Digital Learning in Higher Education, *Digital tilstand 2014*, which follows on from corresponding surveys from 2008 and 2011.

18 cf. Norwegian Ministry of Education and Research’s digitalisation strategy for basic education (2017-2021)

19 NOU 2014:5 *MOOC for Norway*. *New digital learning methods in higher education*.

methods are being developed[20], and exams are digitalised.

A study of how National Governments and institutions shape the development of MOOCs finds five central motivations for adopting MOOCs in Norwegian higher education: 1) strengthen the quality,2) increase access, 3) recruit students and promote Haigher Education Institutions, 4) increase cooperation, and 5) reduce costs[21]. A study of the first international MOOC developed at the University of Oslo finds that students self-organize and establish a scaffolding peer support system to compensate for insufficient interaction with teachers. The study concludes that new pedagogical practices appears to only be in the making for online learning [22].

1.1.1 Student learning and the need for technological competence

White Paper no. 16 (2016-2017) *Culture for Quality in Higher Education* highlights student learning and teaching[23]. One objective is that all students should experience stimulating and varied learning and assessment methods where digital opportunities are exploited. The White Paper further states that technological tools can help students get the best possible education and feedback, also in large student groups. Education should be based on knowledge of how students are best educated and developed. While nine out of ten students report that digital tools are important in their daily student life, only half believe that the tools help them learn better. There are many indications that learning management systems are more successful in *managing* learning than supporting the practice of learning, as institutions do not prioritize implementing digital tools in curricula, subject descriptions and work requirements. There are many high quality open learning resources available online. Student response systems can be a way of engaging the students. Flipped classroom, where students prepare for the lecture in advance, allows the teacher to spend time discussing with the students. Video recording of lectures and/or podcasts give students possibilities for repetitions. Digital learning combined with more traditional classroom learning (blended learning) appear to be effectively enhancing learning.

The long-term plan for research and higher education[24] shows that digitalisation also closes the gap between education and working life by allowing students to work more actively with the subject matter. By allowing each student to choose when he or she wants to focus on the study material, it opens for collaboration between institutions, as well as with the business community, trade and industry. However, as emphasised in a report from the EU commission[25], students are unique, and so is the way they learn. Teaching tools used in universities and colleges should therefore cater for individual learning, with the student at the centre. Digital media can facilitate more active, problem-based learning which has been demonstrated to encourage greater student engagement and improved learning outcomes. Some learn better with the help of interactive media with images, graphics, videos and audio as incorporated elements. Technology can combine these for a personalised learning experience, based on individual strengths.

The EU-report further stresses that teaching staff must be equipped with the necessary skills and knowledge to allow them to fully utilise the range of new teaching tools. New technologies and associated pedagogies require a very different skill-set from more conventional teaching. Academic staff are not all technology experts, and many have had little or no pedagogical training. If they are to deliver quality teaching with technology, they need specific training, guidance and support.

1.1.2 Suggestions for improvement

Digital technologies and pedagogy should be an integral element of higher education institutions' strategies for teaching and learning, and in parallel, a competency framework for higher education teachers' digital skills must be developed. The EU

20 Both the Norwegian Agency for Digital Learning in Higher Education and SLATE are central to these development efforts.

21 Tømte, C. E., Fevolden, A. M., & Aanstad, S. (2017). Massive, Open, Online, and National? A Study of How National Governments and Institutions Shape the Development of MOOCs. *The International Review of Research in Open and Distributed Learning*, *18*(5).

22 Singh, A. B., & Mørch, A. I. (2018). An Analysis of Participants' Experiences from the First International MOOC Offered at the University of Oslo. *Nordic Journal of Digital Literacy, 13*(01), 40-64.

23 Meld. St. 16 (2016–2017)- Kultur for kvalitet i høyere utdanning https://www.regjeringen.no/no/dokumenter/meld.-st.-16-20162017/id2536007/

24 Meld. St. 7 (2014-2015) Long -term plan for research and higher education 2015-2024

25 European Commission (2014) Report to the EU Commission on New modes of learning and teaching in higher education http://ec.europa.eu/dgs/education_culture/repository/education/library/reports/modernisation-universities_en.pdf

Commission[26] argue that member states should be supported in developing national frameworks and infrastructure for integrating new modes of learning and teaching across the higher education system. Legal frameworks that allow higher education institutions to collect and analyse learning data must be developed at national level. The full and informed consent of students is a requirement and the data should only be used for educational purposes. Online platforms should inform users about their privacy and data protection policy and individuals should always be allowed to anonymise their data.

The importance of research leadership in the development of outstanding research is acknowledged, and the same principle applies for outstanding educational achievements. The Long-term plan for research and higher education 2015-2024[27] emphasises closer collaboration between research- and education environments. Developing clusters for international, cross-disciplinary cooperation, combining education, research and innovation, will increase the relevance of the studies and can contribute to making academic work more engaging for the students.

1.2 STATUS AND CHALLENGES

When presented in May 2018, the Status report on Norwegian higher education[28] showed that higher education institutions are not fully exploiting the possibilities inherent in digital technology. While 76 % of students reported that digital tools provide flexibility and freedom and are important for their studies[29], these tools were infrequently or not used. Moreover, 42 % of Norwegian students reported that they only to a small degree experienced pedagogical use of digital technology in their education. When teachers use digital tools, less than 50 % of the students report that the use supports student active learning. How digital tools are used for assessment purposes differs immensely. A forthcoming article from the expert group at Norgesuniversitetet on digital assessment[30] finds that the lack of competence is a huge challenge when using digital tools for assessment purposes. There is too little knowledge about alternatives to the traditional school exam, but also little understanding of how digital tools can be used in assessment.

A report on ICT in teacher education[31] focuses upon how teachers learn to teach by using digital tools. The report finds that the development of professional digital competence is weakly anchored in the management and leadership of teacher education institutions and most institutions lack an integrated approach for competence development. Moreover, the competence amongst the academic staff varies, and the development of teacher students' digital competence are often dependent upon enthusiasts. This is not sustainable, and will affect teacher student's possibilities to make pedagogical use of ICT when they become teachers themselves.

A systematic mapping of the effects of ICT on learning outcome[32] showed that ICT has an impact on learning outcome when technology is implemented as a planned part of a comprehensive teaching environment with clear goals, teaching plans, teaching materials, supporting technical resources, teacher training and development. Hence, it is *how* digital tools are being implemented and pedagogically used that matter for students' learning outcome, not the technology itself. This finding is later confirmed in two reports[33] [34]. It is not the digital technologies *per se* that solve teaching and learning challenges. Digital technologies must be carefully integrated into course designs and their use must be facilitated by teachers[35].

26 European Commission (2014) Report to the EU Commission on New modes of learning and teaching in higher education http://ec.europa.eu/dgs/education_culture/repository/education/library/reports/modernisation-universities_en.pdf

27 Meld. St. 7 (2014-2015) Long -term plan for research and higher education 2015-2024

28 Tilstandsrapport for høyere utdanning 2018 https://www.regjeringen.no/no/dokumenter/tilstandsrapport-for-hoyere-utdanning-2018/id2600317/

29 NOKUT`s Studiebarometer shows student`s perceptions about quality of their study program, http://www.studiebarometeret.no/en/

30 https://norgesuniversitetet.no/ekspertgruppe/digital-vurdering

31 Tømte, C., Kårstein, A., & Olsen, D. S. (2013). IKT i lærerutdanningen: På vei mot profesjonsfaglig digital kompetanse?. NIFU report 20/2013

32 Morgan, K., Morgan, M., Johansson, L. & Ruud, E. (2016) A systematic mapping of the effects of ICt on learning outcomes. Oslo. Knowledge Centre for Education. www.kunnskapssenter.no

33 Damşa, C., de Lange, T., Elken, M., Esterhazy, R., Fossland, T., Frølich, N., ... & Stensaker, B. (2015). Quality in Norwegian higher education: A review of research on aspects affecting student learning. 2015: 24

34 Nerland, M., & Prøitz, T. S. (2018). Pathways to quality in higher education: Case studies of educational practices in eight courses. NIFU report 2018:3

35 Henderson, M., Selwyn, N., & Aston, R. (2017). What works and why? Student perceptions of 'useful'digital technology in university teaching and learning. *Studies in Higher Education*, *42*(8), 1567-1579.

The introduction has shown that the challenges when it comes to utilizing the potential of technology and digitalisation in education are related to leadership, infrastructure, and competence. The systematic review has analysed and synthesised 35 articles about pedagogical use of technology and innovative learning and teaching in higher education, and concludes with prerequisites for how teaching with technology can support student active learning.

1.3 OUTLINE OF THE REVIEW

The systematic review is outlined as follows: Chapter 2 presents the systematic review method, literature search, sorting, quality and relevance assessment of the articles included in the systematic review. Chapter 3 presents the 35 included articles, organised in five subchapters: 3.1 Institutional level: Decision making, 3.2 Learning and teaching across contexts, 3.3 Emerging educational technologies and innovative learning, 3.4 Collaborative learning, 3.5 Barriers to technology use and innovative teaching. Sections 3.4 and 3.5 highlight themes that cross through all the studies. In Chapter 4 the studies are synthesised, and chapter 5 concludes, gives recommendations and shows knowledge gaps.

2 METHOD

A key characteristic of systematic reviews is transparency and the presence of an explicit method that describes and determines their conduct[36]. This systematic review takes the form of a *rapid review*[37], performed to synthesize qualitative and quantitative studies as well as literature reviews and systematic reviews. The rapid review method is a developing format that may be perceived as a compromise between what is expected from a systematic review, and policy-makers' need for evidence to be available in a shorter time than the 1-2 years it typically takes to conduct a full systematic review[38]. Rapid reviews have been defined as brief, readable, and usable responses to guide decision making, typically completed within 6 months[39]. While they differ in format, the similarity of rapid reviews lies in their close relationship with the end-user to meet decision-making needs in an identified timeframe. Rapid reviews are systematic and transparent, and follow the same quality- and relevance assessment procedures as systematic reviews, but make limitations to finish the work in a shorter time span. Typical limitations are: searching fewer databases; limiting the use of grey literature; narrowing the scope; restricting the type of studies included etc[40]. In this systematic review, the following limitations are made 1) only studies published in peer-reviewed journals are included; 2) systematic searches are limited to studies published after 1. January 2012; and 3) language is limited to articles published in English, Norwegian, Swedish or Danish.

The systematic review answers this research question:

> *How can teaching with technology support student active learning in higher education?*

2.1 SEARCHING AND SORTING

Having identified concepts that are central to the research on digitalisation of higher education, a search string with search words was developed and several trial searches conducted in electronic databases. Main electronic searches were conducted 25.09.17 and 28.01.18 in seven databases: Education Collection, Applied Social Sciences Index and Abstracts (ASSIA), International Bibliography of the Social Sciences (IBSS), Education Database, Education Resources Information Center (ERIC), Psycinfo and Scopus. The searches were conducted with free text and thematic words in title and abstract, and resulted in 6513 hits. Appendix 1 shows the search string with the Scopus syntax. In addition, a hand search was conducted 14th and 15th December and supplementary searches 12.12.17; 02.01.18 and 07.02.18. The included articles cover the publication period 2012 to 2018.

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36 Gough, D., Oliver, S. Thomas, J. (2017). *An introduction to systematic reviews*. London: Sage Ltd.

37 Khangura, S., Konnuy, K. Cushman, R., Grimshaw, J. and Moher, D. (2012): *Evidence summaries and the evolution of a rapid review approach, Systematic Reviews*, 1-10.
Featherstone, R. M., Michelle, D. M., Guise, J-M., Mitchell, M.D., Paynter, R. A., Robinson, K. A., Umscheid, C. A., and Hartling, L. (2015): Advancing knowledge of rapid reviews: An analysis of results, conclusions and recommendations from published review articles examining rapid reviews. *Systematic reviews* 4:50.

38 Thomas, J., Newman, M. and Oliver, S. (2013): Rapid evidence assessment of research to inform social policy: taking stock and moving forward, *Evidence & Policy,* 9 (1), 5-27

39 Andradas, E., Blasco, J. A., Valentín, B., López-Pedraza, M. J., & Gracia, F. J. (2008). Defining products for a new health technology assessment agency in Madrid, Spain: a survey of decision makers. *International Journal of Technology Assessment in Health Care*, *24*(1), 60-69.

40 Hartling, L., Guise, J. M., Kato, E., Anderson, J., Aronson, N., Belinson, S., ... & Mitchell, M. (2015). EPC methods: an exploration of methods and context for the production of rapid reviews. Research White Paper. . (Prepared by the Scientific Resource Center under Contract No. 290-2012-00004-C.) AHRQ Publication No. 15-EHC008-EF. Rockville, MD: Agency for Healthcare Research and Quality https://www.ncbi.nlm.nih.gov/books/NBK274092/pdf/Bookshelf_NBK274092.pdf

Title and abstract of all the hits from the literature searches were imported to the software EPPI-reviewer 4, developed for systematic reviewing by the EPPI-centre at the University College, London[42].

Preparing the data for synthesis requires a three-stage process, following pre-defined criteria. At the first stage, articles are read and assessed on title and abstract. At the second stage, articles are read in full-text. At the third stage, data is extracted from the articles, described and prepared for synthesis. Figure 1 illustrates the two first stages of the sorting process in this systematic review:

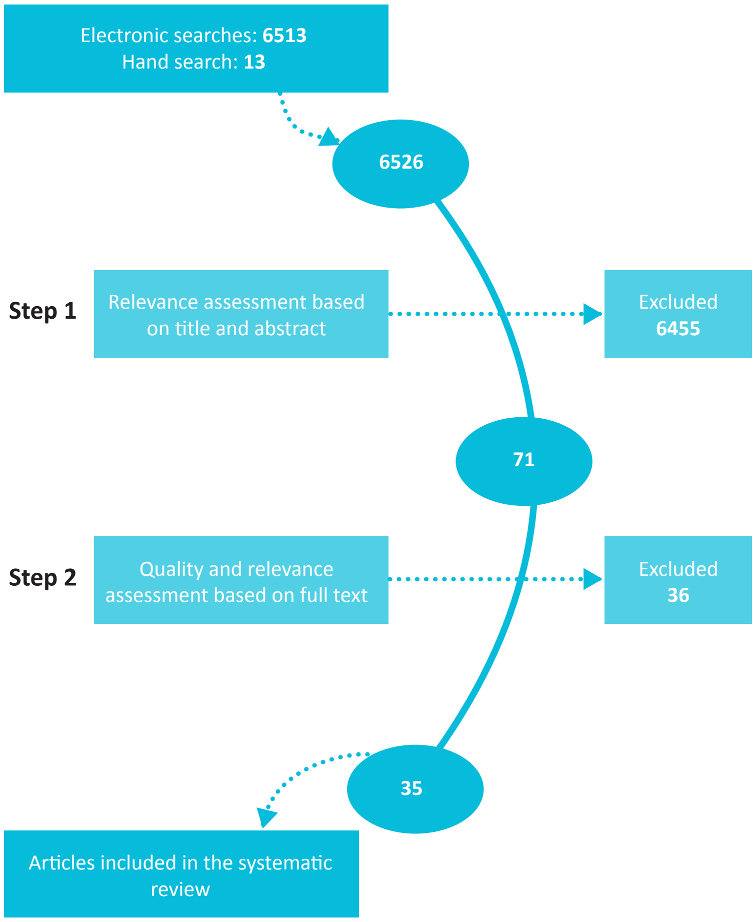

Figure 1. Flow diagram

Stage 1
Table 1 provides an overview of the pre-determined inclusion criteria used in the sorting process.

Table 1. Inclusion criteria

INCLUSION CRITERIA	EXPLANATION
1. Theme	The study must address innovative use of ICT, how technology influences teaching and/or promotes student active learning.
2. Context	Higher education.
3. Publication type	The article must be published in a peer-reviewed journal.
4. Language	The article must be published in English, Norwegian, Swedish or Danish.
5. Citation Index	Include articles with above average ratings.
6. Scimago Journal Ranking (SJR)	Include articles with above average ratings.

41 Gough, D., Oliver, S. Thomas, J. (2017). *An introduction to systematic reviews*. London: Sage Ltd.

Table 2. Criteria for assessing quality

CRITERIA FOR QUALITY ASSESSMENT	ASSESSMENT VALUE
• **Validity** • **Reliability** • **Generalisation** • **Is the research question clearly formulated?** • **Are the research method and the research design specified?** • **Is there alignment between the research question and the study`s findings?**	*High*: Explicit and detailed description of method, data collection, analysis and results; the interpretations/analysis are clearly supported by the findings. *Medium*: Satisfactory description of method, data collection, analysis and results; the interpretations/analysis are partially supported by the findings. *Low*: Weak description of method, data collection, analysis and results; interpretations/analysis have little support in the findings.

Due to the large number of publications identified in the database searches, text mining technology integrated in the EPPI-Reviewer 4 software, called machine learning[42], was used to expedite the identification of relevant research. Machine learning is an iterative process by which the machine learns from the researchers which articles should be included or excluded. The machine makes continuous relevance calculations and sorts the data so that the most relevant articles are added first in the screening process. After screening a limited number of articles, most of the relevant articles are identified. This technology makes it possible to screen large amounts of data in less time[43].

The inclusion criteria number 5. Citation index and number 6. Scimago Journal Rank Indicator were applied the following way: The total number of citations for each article was identified in Google Scholar, and the number of citations per year calculated, not counting the publication year. Having calculated the annual average number of citations for all articles; articles with above average ratings were included. This ensures that articles have high quality and relevance within their field of research.

As articles normally have few citations the first year(s) of publication, articles published in 2017 and 2018 were assessed based on the Scimago Journal Rank indicator (SJR indicator), a measure of scientific influence of scholarly journals that accounts for both the number of citations and the prestige of the journals citing the article. The 2016 SJR indicator was obtained from the Scopus title list index. Only articles published in journals with above average ranking were included.

After the relevance assessment on stage one based on title and abstract, 71 articles with potential relevance for the systematic review were identified.

Stage 2:
At the second stage, the 71 articles with potential relevance were read in full text. Two researchers assessed, independently, the studies' quality and relevance for the review. Table 2 gives an overview of the quality criteria used. The studies are scored high, medium or low. After the second step, 35 articles remained, and are included in the systematic review.

2.2 PREPARATION FOR SYNTHESIS

To synthesize the included articles an overview of the data material is needed to facilitate data extraction. First a mapping is conducted. The mapping show that the articles are from 14 different countries and published between 2012 and 2018. Table 3 show the mapping on country based upon the first author`s affiliation.

42 Thomas, J., & O'Mara-Eves, A. (2011). How can we find relevant research more quickly? In: *NCRM Methods News. UK: NCRM; 2011. p. 3.*

43 O'Mara-Eves, A., Kelly, M. P., & Thomas, J. (2014). Pinpointing needles in giant haystacks: use of text mining to reduce impractical screening workload in extremely large scoping reviews. *Research Synthesis Methods*, *5*(1), 31-49.
O'Mara-Eves, A., Thomas, J., McNaught, J., Miwa, M., & Ananiadou, S. (2015). Using text mining for study identification in systematic reviews: a systematic review of current approaches. *Systematic reviews*, *4*(1), 5
Wallace, B. C., Trikalinos, T. A., Lau, J., Brodley, C., & Schmid, C. H. (2010). Semi-automated screening of biomedical citations for systematic reviews. *BMC bioinformatics*, *11*(1), 55.

Table 3. Mapping of country

COUNTRY	NUMBER OF STUDIES
Australia	5
Canada	1
Cyprus	1
Emirates	1
Israel	2
Italy	1
Korea	1
New Zealand	1
Spain	1
South-Africa	3
Switzerland	1
Taiwan	2
UK	8
USA	6
TOTAL	35

The mapping further shows that 4 studies have used quantitative methods, 10 have used qualitative methods, 10 studies are based on both quantitative and qualitative methods, 2 papers are theoretical and 7 papers are reviews (3 systematic reviews and 4 literature reviews). 2 papers have used mixed methods. 20 studies are scored with high quality, 15 with medium quality and none with low quality. Appendix 2 shows method used and quality of the articles.

Having mapped the papers on theme, the included articles were categorised as follows:

CATEGORY	ARTICLES
Institutional level: Decision making	Avella et al. (2016); Rienties & Toetenel (2016); Lee, Morrone & Siering (2018); Maringe & Sing (2014); Toven-Lindsey et al. (2015).
Learning and teaching across contexts • **Lecture capture** • **Mobile learning** • **Blended and hybrid learning contexts**	Witton (2017); Al-Nashash & Gunn (2013); Hung, Kinshuk & Chen (2018); Dennen & Hao (2014); Pimmer, Mateescu & Gröhbiel (2016); Cochrane (2014); Mesh (2016); Wanner & Palmer (2015); Blau & Shamir-Inbal (2017); Ali et al. (2017).
Emerging educational technologies and innovative learning • **Augmented Reality** • **Games and interactive response systems** • **Pedagogical implications of emerging technologies**	Wang (2017a); Blanco-Fernandez et al. (2014); Lameras et al. (2017); Vlachopoulos & Maki (2017); Edmonds & Smith (2017); Wang (2017b); jones & Bennett (2017); Barak (2017); Ng'Ambi (2013); Van Es et al. (2016).
Collaborative learning	Tegos et al. (2016); Akiyama & Cunningham (2018); Newland & Byles (2014); Rambe & Bere (2013); Zheng et al. (2015).
Barriers to technology use and innovative teaching	Amemado (2014); Kirkwood & Price (2013); Shelton (2017); Sinclair & Aho (2018); Walker, Jenkins & Voce (2017).

A configurative synthesis

Once the articles are categorised, data is extracted and each article is briefly summarised. The goal is to elicit the meaning of the study, an idiomatic translation[44]. The brief summaries make it possible to analyse and synthesize the studies to identify common patterns across the data. Synthesis is an analytic activity that generates new knowledge and understanding in response to the review`s research question, and a synthesis is normally more than simply the sum of its parts[45]. A configurative synthesis aims to find similarities between heterogenous studies, even when they use different concepts to describe similar events[46], which is the case in this systematic review. Translation is central to configurative synthesis, and the ambition is to contribute to clarification, theory development, and conceptual innovation. The synthesis results in a narrative that answers the research question by identifying transcending patterns in the included studies[47]. The goal is not simply to list the findings, but to interpret findings from each study in a way that contributes to new knowledge. Data sources in systematic reviews are the included studies, and the synthesising process aims at *translating* the studies into each other[48] or make them *talk to each other*[49] to generate insights that transcend each study's contribution.

Based on analysis of the brief summaries, two transcending patterns were identified across the studies: 1) From content delivery to student active learning and 2) Professional development of staff. To analyse the patterns in depth, all the articles were uploaded to NVivo Pro 11, and coded accordingly. Data extracts concerning student active learning, collaboration and professional development and training were analysed in depth, before the studies were synthesised.

44 Noblit, G.W. & Hare, R.D. (1988) *Meta-ethnography: Synthesizing qualitative studies*. Sage`s university paper series on Qualitative research methods volume 11, California: Sage publications

45 Gough, D., Oliver, S., & Thomas, J. (2017). *An introduction to systematic reviews*, p.182, London: Sage.

46 Etymologically, *configure* means to piece together parts to form an overall picture.

47 Popay, J., Roberts, H., Sowden, A., Petticrew, M., Arai, L., Rodgers, M., & Duffy, S. (2006). Guidance on the conduct of narrative synthesis in systematic reviews. *A product from the ESRC methods programme. Version*, *1*.

48 Noblit, G. W., & Hare, R. D. (1988). *Meta-ethnography: Synthesizing qualitative studies* (Vol. 11). Sage.

49 Gough, D., Oliver, S., & Thomas, J. (2012). *An introduction to systematic reviews*, p. 188, London: Sage.

3 PRESENTATION OF THE INCLUDED ARTICLES

Chapter 3 presents the 35 included articles. Figure 2, below, shows how the chapter is organised into five subchapters (3.1. – 3.5).

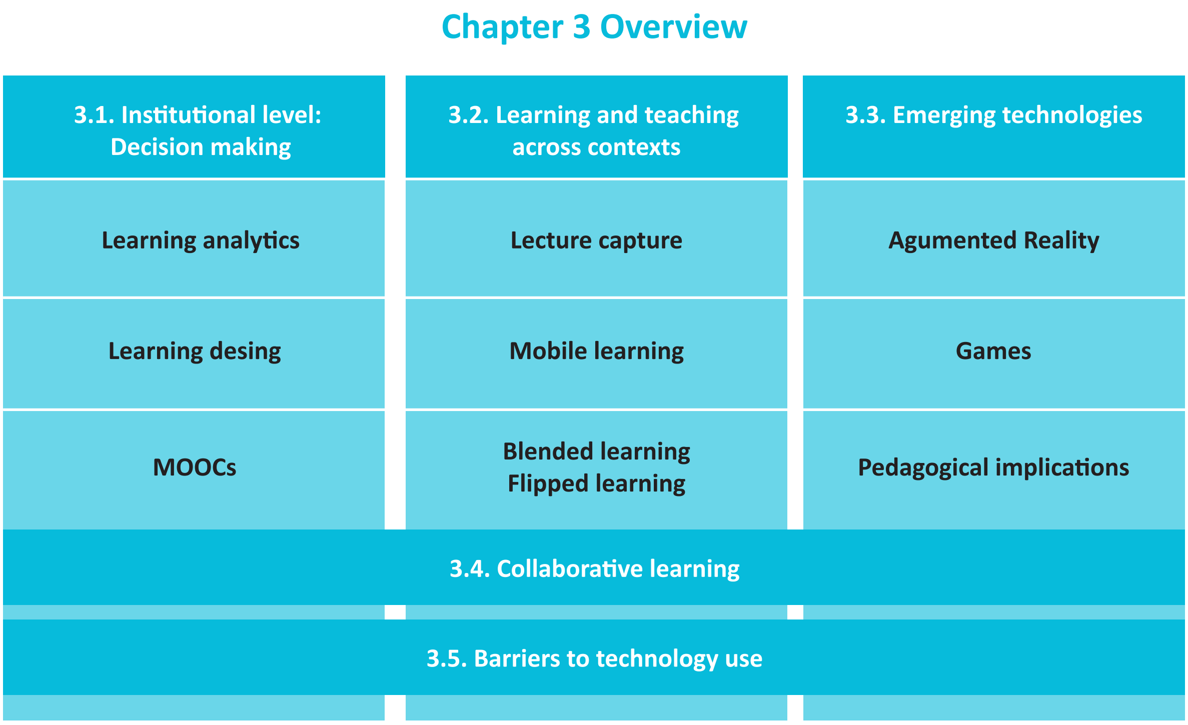

Figure 2. Overview of chapter 3

In 3.1.: *Institutional level: Decision making,* studies with relevance for policymakers and higher education leaders and administrators are presented. These studies cover themes such as learning analytics (LA), learning design and MOOCs and provide information about big data, knowledge utilisation, evaluation and big-scale initiatives that require leaders' attention, funding and institution-wide training and support if they are to reach the potentials inherent in new technologies. Learning analytics is a vast and rapidly growing research field with the potential to generate information institutions can use when designing learning. Designing productive learning environments is, however, a very complex task that cannot solely be the responsibility of individual staff members. Institutions must develop policies that state how they want students to learn, initiate and lead change processes and follow up with data analysis, training and support.

Subchapter 3.2.: *Learning and teaching across contexts,* presents studies where the underlying assumption is that teaching no longer can be the sole responsibility of individual teachers. To gain status, teaching must be a more knowledge-informed activity with work processes better aligned with those academics use when they engage in research. Data gathered through learning analytics can be used to design innovative learning environments where students and teachers collaborate to reach the broad spectre of learning goals. The studies presented here have researched potential educational benefits of combining digital and physical learning environments and focused on characteristics of learning designs that may enhance student learning. The studies cover themes such as lecture capture, mobile learning, blended and flipped learning.

The potential of educational benefits is even more strongly emphasised in sub chapter 3.3.: *Emerging educational technologies and innovative learning,* where the presented studies show promising emerging technologies and what is required of institutions, facilities, leaders and staff for these innovations to be an integral part of the institutions' teaching practice.

The two last subchapters, 3.4. and 3.5., are visualised as crossing themes because all the included articles stress the educational benefit of collaborative learning and most studies find barriers to innovative teaching. In 3.4.: *Collaborative learning*, collaborative learning approaches in online learning and teaching are presented, for instance how conversational agents may promote academically productive interactions, modalities and practices in telecollaboration, what promotes and hinders collaborative technology use in higher education and social learning practices with apps and wikis.

In 3.5.: *Barriers to technology use and innovative teaching*, studies find barriers to technology use in higher education institutions, and argue that these barriers may also explain why teaching in higher education institutions largely remains prescriptive and teacher-centered, even when the intention is a student-active approach to learning.

3.1 INSTITUTIONAL LEVEL: DECISION MAKING

While new technologies open the way for new possibilities, they also bring practical, financial and ethical issues that go beyond the responsibility of individual staff members, teams or departments. This first chapter therefore presents five studies that have investigated questions related to digitalisation of higher education with implications for the *institutional* level, i. e. top level strategists, managers and administrators, faculty, and/or department leadership.

Studies show that for implementation to succeed, leaders must develop policies and guidelines, make funding available and provide the necessary training and competence development for staff and students. The first three studies give an overview of the emerging field of learning analytics and how learning and teaching can be *designed*, based on systematic analysis and utilisation of big data. The fourth study describes developing trends in higher education and the last study describes challenges encountered when developing, running and renewing MOOCs.

AUTHORS	COUNTRY	HAVE INVESTIGATED	METHODS USED
Avella et al. (2016)	USA	Learning analytics	Systematic review
Rienties & Toetenel (2016)	UK	Learning design	Multiple regression models
Lee, Morrone & Siering (2018)	USA	Pedagogy, space, technology	Convergent parallel mixed methods design, triangulation (interview, surveys, syllabi)
Maringe & Sing (2014)	South Africa	Development trends in HE	Theoretical
Toven-Lindsey et al. (2015)	USA	Pedagogical tools used in MOOCs	Qualitative multi-case study analysis

3.1.1 Learning analytics, learning design and MOOCs

The advancement of technology has provided the opportunity to track and store students' online learning activities as big data sets. The purpose of learning analytics (LA) in such a context is to tailor educational opportunities to individual learners' needs and abilities, such as providing adapted feedback and timely instructional content. While there is no universally agreed definition of learning analytics, it refers to activities such as the measurement, collection, analysis and reporting of data about learners and their context, with the purpose to understand and optimise learning and the environment in which it occurs[50]. There is a growing interest in how institutional data can be used to understand academic retention, for instance to identify students' pattern of behaviour in online education to improve students' learning, figure out how teaching can be more engaging and increase retention rates.

Learning analytics is a multi-disciplinary approach based on data processing, technology-learning enhancement, educational data mining, and visualisation[51], more specifically the process of systematically collecting and analysing large data sets from online courses, with the purpose to improve learning processes[52]. LA can help learners and educators make constructive decisions and more effectively perform their tasks. *Analytics* refers to the scientific process that examines data, presents paths to make decisions and formulates conclusions[53]. Examples of concepts frequently used in this research field, and their meaning, is presented here:

CONCEPT	MEANING OF CONCEPT
Big Data	The capability of storing large quantities of data over an extended period and down to the particular transaction.
Data analytics	The scientific process that examines data to formulate conclusions and to present paths to make decisions.
Educational data mining *Academic analytics* *Learning analytics*	*Data mining* uses algorithms to solve educational issues and develop new computational data analysis methods. *Academic analytics* is an application of business intelligence methods and tools to performance and decision-making in the educational institutions. *Learning analytics* tries to improve student learning and learning environments through methods such as predictive analysis, clustering, and relationship mining.

Learning analytics integrates and uses analysis techniques such as data mining, data visualisation, machine learning, social network analysis, semantics, artificial intelligence and e-learning. Social network analysis (SNA) analyses relationships between learners as well as between learners and instructors to identify when students are engaged or disconnected. Visual data analysis includes highly advanced computational methods and graphics to expose patterns and trends in large, complex datasets[54]. Other methods are predication, clustering, relationship mining and discovery with models.

Researchers currently argue that LA should take a *social* turn as most research aims at predicting individual performance. They fear that simple LA metrics (e.g. number of clicks, number of downloads) may hamper the advancement of LA research and argue that "simple" LA metrics provide limited insight

50 http://www.laceproject.eu/faqs/learning-analytics/

51 Scheffel, M., Drachsler, H., Stoyanov, S., & Specht, M. (2014). Quality indicators for learning analytics. *Journal of Educational Technology & Society*, *17*(4), 117.

52 Brown, M. (2012). Learning analytics: Moving from concept to practice. EDUCAUSE Learning initiative. https://library.educause.edu/resources/2012/7/learning-analytics-moving-from-concept-to-practice

53 Picciano, A. G. (2012). The evolution of big data and learning analytics in American higher education. *Journal of Asynchronous Learning Networks, 16*(3), 9-20.

54 Examples are Gapminder, IBM Many Eyes, FlowingData and Visualization community.

into the complexity of learning dynamics[55] and the relational nature of teaching and learning. While clicking behaviour explains around 10 % of variation in academic performance; motivation, emotions and learners' activities account for 50 % of the variation.

Avella et al. (2016) conducted a systematic review with the ambition to answer three questions: What does the research on learning analytics say about *methods* used in LA; what does it say about *benefits* of using LA, and what does it say about *challenges* encountered when using LA? A systematic search, with the explicit goal to find *empirical* studies, generated 112 articles. Among these, 10 addressed *methods*, 16 focused on *benefits* and 18 on *challenges*. The next section presents and summarises how the included articles answer the three review questions:

1. Learning analytics *methods*

Learning analytics begins with leaders who are committed to decision-making based on institutional data. This commitment must be reflected in the hiring of administrative staff, skilled at data analysis, and training staff in understanding the potential and proper ethical conduct of data-driven decision-making. Five stages of data capturing are identified[56]: 1) reporting the data pattern and trends; 2) predicting a model based on the data; 3) acting by using an intervention based on the model to 4) improve learning and teaching and, 5) refining the developed model. Researchers suggest a macro-level process perceiving the LA process as a flow of information in the system, from the students to the stakeholders within the framework of a hierarchy or a cycle[57], where researchers collect data from the students, process the data into metrics, use the results to perform an intervention, and collect additional data for the next iterative cycle.

2. Learning analytics *benefits* for education

Avella et al. (2016) found that careful analysis of big data may help stakeholders to elicit useful information that can benefit educational institutions, students, instructors, and researchers. The benefits are listed and exemplified below:

STAKEHOLDER BENEFITS REPORTED BY RESEARCH	EXAMPLES
Targeted course offering	By examining trends, institutions can predict graduate numbers for long-term planning
Curriculum development	Analysing big data, educators can determine weaknesses in student learning and comprehension and use this for improvement purposes
Students' learning process, learning outcomes and behaviour	Data analysis helps educators understand the students' learning experience
Personalised learning	LA allows for real-time reception, review and incorporation of data, and real-time feedback to students
Improved instructor performance	Data analysis can identify areas in need of improvement by the instructor to facilitate enhanced instructor-student interactions
Post-educational employment opportunities	Using big data can help stakeholders better assess student learning programs for vocational compatibility
Improved research in the field of education	Researchers can more easily share information and collaborate, identify gaps and accumulate knowledge

55 Tempelaar, D. T., Rienties, B., & Giesbers, B. (2015). In search for the most informative data for feedback generation: Learning Analytics in a data-rich context. *Computers in Human Behavior*, *47*, 157-167.

56 Campbell, J. P., DeBlois, P. B., & Oblinger, D. G. (2007). Academic analytics: A new tool for a new era. *EDUCAUSE review*, *42*(4), 40.

57 Clow, D. (2012). The learning analytics cycle: closing the loop effectively. In *Proceedings of the 2nd international conference on learning analytics and knowledge* (pp. 134-138). ACM.
Clow, D. (2013). An overview of learning analytics. *Teaching in Higher Education*, *18*(6), 683-695.

3. Learning analytics *challenges* in education

Avella et al. (2016) found the following learning analytics challenges:

AREAS OF CHALLENGE	EXAMPLES
Data tracking	Monitoring via Learning Management Systems, Platforms (Moodle, Canvas, EPIC, Blackboard); information about student log-in, involvement, how engaging the curriculum presented is, which areas that cause confusion
Data collection	Availability of resources, viable social platform, difficulties in sharing proprietary information, competition between bidders instead of teamwork
Data evaluation and analysis	For LA to help instructors, data must be delivered timely and accurately. Technical challenges, errors may occur when manually conducting data analysis
Connection with learning sciences	To optimise learning requires understanding how to support knowledge development, connecting cognition, metacognition, and pedagogy
Learning environment optimisation	Individual and social learning analytics, better understanding of the learning context. Research focusing on LA and pedagogy is still in the early stages
Emerging technologies	Learning analytics develops as new technologies emerge.
Ethical concerns, legal and privacy issues	Privacy considerations such as consent, data accuracy, how to respect privacy, maintain anonymity, opting out of data gathering. Data interpretation, ownership, sharing, who owns aggregate data. Four guiding principles: 1) Clear communication; 2) Care; 3) Consent and 4) Complaint.

The review revealed that LA is an interdisciplinary field that selects and uses methods and analysis techniques from other disciplines to achieve the goal of improving education. Mechanisms must provide transparency, data controls by students, information security, and accountability safeguards. The research field of Learning Analytics also stresses the ethical implication of data collection and use[58] and DELICATE is one suggested framework:

D-etermination: Decide on the purpose of learning analytics for your institution.
E-xplain: Define the scope of data collection and usage.
L-egitimate: Explain how you operate within the legal frameworks, refer to the essential legislation.
I-nvolve: Talk to stakeholders and give assurances about the data distribution and use.
C-onsent: Seek consent through clear consent questions.
A-nonymise: De-identify individuals as much as possible
T-echnical aspects: Monitor who has access to data, especially in areas with high staff turn-over.
E-xternal partners: Make sure externals provide highest data security standards.

Rienties & Toetenel (2016) used multiple regression models when linking 151 modules and 111.256 students with student behaviour, satisfaction and performance at the Open University (OU), UK. The OU has used learner feedback to improve students' learning experience and learning designs for 30 years, and academic retention ranges between 34,46% and 100%, with an average of 69,35%. Learning design (LD) is described as *a methodology for enabling teachers/ designers to make more informed decisions in how they go about designing learning activities and interventions, which are pedagogically informed and make effective use of appropriate resources and technologies*[59].

The study aims to figure out *to what extent* learning design decisions made by teachers predict student engagement, satisfaction and academic performance. Virtual Learning Environment (VLE) data was collected

58 DELICATE, developed within the LACE-project http://www.laceproject.eu/ethics-privacy/

59 Conole, G. (2012). *Designing for learning in an open world*. Dordrecht: Springer, p. 121.

per module: a) average time spent on VLE per week; b) average time spent per session on VLE.

Learning design is process based and follows a collaborative design approach in which practitioners make informed design decisions with a pedagogical focus. Five categories describe options available for teachers to create an interactive, *social* learning environment where activities are 1) *Communicative*; 2) *Productive*; 3) *Experimental*; 4) *Interactive*; and 5) *Assessed*.

This is an overview of OULDI[60] learning design activities:

LABEL	TYPE OF ACTIVITY	EXAMPLE
Assimilative	Attending to information	Read, watch, listen, think about, access
Finding/handling information	Searching for and processing	List, analyse, collate, plot, find, discover, access, use, gather
Communication	Discussing module content with at least one other person	Communicate, debate, discuss, argue, share, report
Productive	Actively constructing an artefact	Create, build, contribute design, construct,
Experiential	Apply learning in real-world setting	Practice, apply, experience, mimic, explore, investigate
Interactive/adaptive	Apply learning in simulated setting	Explore, experiment, trial, improve, model, simulate
Assessment	All forms	Write, present, report, demonstrate, critique

60 Open University Learning Design Initiative (OULDI)

The dependent variable was academic retention (the number of learners who completed and passed the module relative to the number of learners who registered for each module). Analytics data included the level of the course, the discipline, year of implementation, size of class or module. All data were collected on an aggregate, module level. Learning design (LD) data was merged with virtual learning environment (VLE) and learner retention data based upon module ID and year of implementation.

Positive correlations were found between *finding information* and *communication*, and between *productive* and *experiential* outcomes. Total workload was positively related to communication and experiential and negatively to assessment, indicating that teachers dedicated relatively more time for learning activities and less for assessment.

The study finds that learning design activities strongly influenced academic retention, with the relative amount of communication activities and time spent on communication as primary predictors, controlling for institutional and disciplinary factors. As the focus in online learning tends to be on designing for *cognition* rather than social learning activities, this is an important finding. A second finding is that learner satisfaction was strongly influenced by learning design, while learner satisfaction and retention was not. This may indicate that learning at times can be hard and difficult, and not always a pleasant experience. Universities must consider how they can balance designing learning activities that stretch students to their maximum ability, while keeping students happy.

Rienties & Toetenel (2016) conclude that learning design had a significant and substantial impact on learner experience. Communication seemed to be a key lever for retention in blended and online distance education at the OU. Modules with more assimilative and fewer inquiry and discovery-based learning activities were perceived to lead to better learner experiences. Separate analysis indicated that assimilative activities significantly and positively predicted learner satisfaction. To enhance academic retention, a way forward may be appropriate, well-designed communication tasks that align with the learning objectives of the course.

Lee, Morrone and Siering (2018) investigated instructional components and class activities that support active learning in a collaborative learning studio (CLS) with 29 students, and how spatial and technological features reflect design and implementation processes. *Active learning* is used about instructional approaches that actively engage students in the learning process through collaboration, cooperation and discussions, rather than having them passively receive information from their instructors. Data were collected through interviews with faculty (semi-structured) and students (focus-group), surveys (faculty and students) and syllabi for courses taught in the CLS.

COLLABORATIVE LEARNING STUDIO (CLS)	TECHNOLOGIES
Designed for active learning *Small-group activities* *Movable chairs and monitors in U-shaped student tables*	Video wall, control panels, push capabilities, projector screens, student monitors, instructor desktop, wireless microphone, document cameras, student desktops and push-to-talk microphone on student tables.

The lecture was an essential component in most courses, used to frame learning content for students, communicate main ideas before and after group activities and to invite guest lectures. Students generally found the collaborative learning space helpful in their learning (n=25), but some students felt it hindered learning (n= 7). Most students (23 of 29) favored group activities and 11 reported lectures as least favorable.

Four collaborative learning patterns were revealed: 1) lecture – group activities – class-wide discussion (5 courses); 2) lecture – group activities almost daily (3 courses); 3) lecture – group activities once in a while (1 course); 4) group activities – class-wide discussion (1 course). Students and faculty rated group activities as working best, either computer-based, non-computer based group discussions, paper-based or physical group activities. Class wide discussion typically started with a presentation of group work, followed by instructor and student comments and was a central component of collaborative learning, as it allowed students to reflect on their own group activities and connect group work to the course content.

The combination of lectures and discussion emphasises the importance of flexibility in classroom design. Training of how to use the in-room technologies is valued, and the faculty interviewees said they needed time to explore the technologies to know how to implement new pedagogical approaches and better utilise the room features. Also, timely technical assistance was important.

Maringe & Sing (2014) identify four drivers in Higher Education: 1) *Massification*; 2) *Mobility*; 3) *Marketisation*; and 4) *Stagnating staff numbers*. In a theoretical article they address issues of large, demographically diverse university classes, defined as "any class where the number of students pose both perceived and real challenges in the delivery of quality and equal learning opportunities to all students in that classroom" (p.763). Four pedagogical principles underpin the equity dimension. A) Increased student participation and engagement requires teachers to provide prior readings, allowing students to summarise their thoughts on the topic before the session, create buzz-groups etc.; B) Increased curricula access requires teachers to ensure that students have access to teaching material; C) Increased staff intercultural understanding requires teachers to engage students in discussions on how they may benefit from the course; D) Increased opportunities for deep learning for all requires teachers to inspire students through critical engagement with texts and the application of conceptual ideas in designing research questions and empirical investigations. Maringe & Sing (2014) also identify four quality measures of critical importance for a quality learning experience in HE: 1) Continuous monitoring of student satisfaction; 2) Increased opportunities to achieve; 3) Diversification of assessment and 4) The potential of MOOCs.

Toven-Lindsey, Rhoads &Lozano (2015) have investigated frequently used pedagogical tools in 24 MOOCs and provide a brief history of MOOCs before presenting their study.

A MOOC is a model for education delivery typically defined as "*massive*, with theoretically no limit to enrolment; *open*, for anyone to participate, usually at no cost; *online*, with learning activities taking place over the web; and a *course*, structured around a set of learning goals in a defined area of study"[61]. The term *massive open online course* (MOOC), was first used in 2008, to describe a course on learning theory taught by George Siemens and Stephen Downes at the University of Manitoba[62]. The original ambition was to create an open, collaborative online learning community centred around "the active engagement of several hundred to several thousand students who self-organise their participation according to learning goals, prior knowledge and skills, and common interests"[63]. Since 2012, when private companies including Coursera and Udacity were established, the goals of the MOOC movement have shifted to encompass the massification of existing courses and potential for revenue generation. Empirical research on teaching strategies and learning outcomes associated with MOOCs is limited.

Although there is significant variation in pedagogical approaches, most courses still utilise traditional classroom methods (lectures, group discussions and multiple-choice assessment). Research finds that students are more satisfied with online courses that include higher levels of interaction and reflection[64] and a major challenge for MOOC instructors has been opportunities for interaction and engagement between students and the instructor as MOOCs often rely on automated instructional tools and completion rates have been extremely low[65].

The initial pedagogical model of MOOCs focused on incorporating high levels of learner control, offering synchronous, or real-time, sessions with the facilitator and other speakers, providing a digital artefact that summarised course activities (i.e. participant blogs,

61 Educause (2013). Seven things you should know about MOOCs II. Educause learning initiative (Retrieved from http://net.educause.edu/ir/library/pdf/ELI7097.pdf).

62 Parry, M. (2010, August 29). Online, bigger classes may be better classes. The chronicle of higher education Retrieved from http://chronicle.com/article/Open-Teaching-Whenthe/124170.

63 McAuley, A., Stewart, B., Siemens, G., & Cormier, D. (2010). The MOOC model for digital practice. Retrieved from. https://oerknowledgecloud.org/sites/oerknowledgecloud.org/files/MOOC_Final_0.pdf

64 Arbaugh, J. B. (2000). How classroom environment and student engagement affect learning in Internet-based MBA courses. Business Communication Quarterly, 63(4), 9–26
Vonderwell, S., Liang, X., & Alderman, K. (2007). Asynchronous discussions and assessment in online learning. *Journal of Research on Technology in Education*, 39(3), 309–328.

65 Parr, C. (2013, May 10). Not staying the course. Inside Higher Ed (Retrieved from http://www.insidehighered.com/news/2013/05/10/new-study-low-mooc-completion-rate).

posts, online discussion), developing dynamic social systems as a means of participant organization and collaboration[66]. Students are assessed automatically, by their peers, or engage in self-assessment. MOOCs require that participants be self-directed and have a level of critical literacy adequate to navigate the course and engage in the learning community[67]. While more experienced and independent students may thrive in this environment, many participants struggle with the lack of structure and instructional support inherent in courses[68].

MOOCs are expected to be disruptive, and transform higher education by creating a 'revolution'. Yet, at present, the major providers are developing open online courses that mimic traditional face-to-face courses with a focus on measurable learning outcomes, which may stifle creativity among instructors and developers.

66 McAuley et al. (2010) op.cit.

67 Kop, R. (2011). The challenges to connectivist learning on open online networks: Learning experiences during a massive open online course. *The International Review of Research in Open and Distance Learning, 12*(3), 19–38.

68 Kop, R., Fournier, H., & Mak, J. S. F. (2011). A pedagogy of abundance or a pedagogy to support human beings? Participant support on massive open online courses. *The International Review of Research in Open and Distance Learning, 12*(7), 74–93.

In their study, Toven-Lindsey, Rhoads and Lozano (2015) investigated the range of pedagogical tools used in 24 MOOCs from public and private universities, private companies, and not-for-profit enterprises, covering several topics and disciplines (social sciences, humanities and STEM) and consider the extent to which these courses provide students with high-quality, collaborative learning experiences. The study answered the following research questions:

1. What instructional tools and pedagogical practices are being utilised in MOOCs?
2. How are new digital and networked technologies impacting the delivery of MOOCs?
3. To what extent are MOOCs able to provide a space for critical inquiry and active student engagement in the learning process?

Data was collected by reviewing the curriculum, content and various instructional elements of the online courses. The Teaching Approach Framework[69] was used to identify and categorise the pedagogical tools, and pedagogical approaches identified were grouped in four categories – objectivist-individual, objectivist-group, constructivist-individual and constructivist-group:

69 Arbaugh, J., & Benbunan-Fich, R. (2006). An investigation of epistemological and social dimensions of teaching in online learning environments. *The Academy of Management Learning and Education, 5*(4), 435–447.

EPISTEMOLOGICAL DIMENSION	OBJECTIVIST: **Assumes a single objective reality and focuses on the transmission of knowledge, instructional sequencing and individual mastery**		CONSTRUCTIVIST: **Assumes that students construct their knowledge independently by actively interacting with the subject matter, combining information from different sources**	
SOCIAL DIMENSION	INDIVIDUAL	GROUP	INDIVIDUAL	GROUP
PEDAGOGICAL APPROACH	• Video recordings • Computer graphics • Text-based lessons and assignments	• Discussion board • Assignments/ exams submitted to deadlines	• Open-ended, short-response questions in assignments and quizzes • External resources; websites, open access textbooks, reports, online labs, simulations	• Peer-reviewed writing assignments • Group activities or debates on the discussion board • Live video conferencing with the instructor

1. **Objectivist-individual approach:** All 24 MOOCs had an objectivist individual approach; 18 used text-based lessons and readings, illustrations, simulations, and review questions to encourage engagement; 22 used video recordings (PowerPoints with voiceover instruction, recordings of the instructor speaking directly into the camera, an animated whiteboard, recordings from a traditional classroom setting, full animation or use of an avatar)[70].
2. **Objectivist-group approach:** The objectivist-group is based on a one-way transmission of content from the instructor, requiring students to collaborate on group assignments, and was common in MOOCs with a specified start and end date. 11 MOOCs used a pre-determined timeline for instruction and an online discussion board to encourage student interaction. Students generally moved through the material at the same time, accessed information weekly and submitted assignments/exams by specific deadlines.
3. **Constructivist-individual approach:** Eight MOOCs used open-ended, short-response questions in assignments and quizzes. Students could compare their response to a computer-generated answer key provided by the instructor, but were encouraged to utilize external resources, including websites, textbooks, reports, and online labs and simulations. In six MOOCs students were encouraged to engage with the material and reflect on learning in their context.
4. **Constructivist-group approach:** encourages collaboration and critical inquiry among participants. While none of the MOOCs in this study utilized this approach for the majority of course activities, one third of the courses incorporated a constructivist-group activity in some way, including peer-reviewed writing assignments, group activities or debates on the discussion board, and live video conferencing with the instructor.

Five courses were based on open-ended questions and required written responses that were reviewed by fellow students. Students earned points for participation more than substance, and course discussion boards showed mixed reviews of the effectiveness of the peer-review process.

70 Example from the open Yale course in Toven-Lindsey, Rhoads & Lozano, (2015, p. 6)

While peer-reviewed writing assignments can be a highly useful tool, students in MOOCs complete these activities independently and with limited opportunity for collaboration. Even discussion boards do not necessarily encourage group collaboration and learning since students generally just respond to questions posted and do not engage in a dialogue on the topic[71].

An objectivist-individual approach would be appropriate if the goal is to increase efficiency by making instruction scalable to an unlimited audience. Transfer of knowledge from expert to novice is, however, insufficient If the goal is to use technology to enhance instructional quality and provide meaningful learning opportunities. Only in a few of the MOOCs, and with mixed results, did instructors use the boards to post discussion topics, requiring students to comment, or initiating group activities. The dominance of the objectivist approach raises questions about the kind of knowledge that is valued in open online education.

Even though the objectivist-individual teaching approach was prevalent, nearly half of the courses incorporated at least one instructional tool that encouraged participants to actively link curriculum to real world settings, or interact with fellow learners. Compared to courses in other fields, MOOCs in the hard sciences were less likely to incorporate constructivist teaching approaches.

If MOOCs are to achieve the revolutionary potential anticipated, the focus should be on creating a community of learners and give students an opportunity to deepen their understanding through collaborative learning.

3.1 Institutional level: Decision making has identified international trends in higher education such as massification, diversity, mobility, personalisation and stagnating staff numbers. These trends emphasise that institutions must establish systems for continuous learning, where data gathered is systematically transformed into action-relevant information that can be used to design learning environments better adapted to students' individual and social needs. Learning Analytics has the potential to provide useful big and small data for this work.

71 Example criminal law, Toven-Lindsey, Rhoads & Lozano (2015, p. 8)

Central to learning designs adapted to student active learning is possibilities to investigate, communicate, produce, experiment, interact, and participate in varied forms of assessment.

3.2 LEARNING AND TEACHING ACROSS CONTEXTS

This chapter presents ten studies researching the potential educational benefits of a combination of recorded lectures and a variety of traditional classroom practices across *digital* and *physical* learning contexts. The researchers are interested in which learning designs or characteristics of designs may enhance student learning. The more overarching term used for this category of studies is *capture technologies*, and the specific labels used are *lecture capture*, *mobile learning* and *flipped learning*. First, three studies on lecture capture, webcast lectures and interactive video lecture are presented; then three studies on mobile learning, and finally four on blended and flipped learning designs.

AUTHOR	COUNTRY	HAVE INVESTIGATED	METHODS USED
3.2.1 Lecture capture			
Witton (2017)	UK	Lecture capture	Pilot – evaluated by a survey
Al-Nashash & Gunn (2013)	Emirates	Students benefits and drawbacks of using webcast lectures	Survey, focus groups interview and statistics
Hung, Kinshuk & Chen (2018)	Taiwan	Interactive video lecture	Experiment – between subjects design
3.2.2 Mobile learning			
Dennen & Hao (2014)	USA	A framework for mobile learning	Authors' own case descriptions
Pimmer, Mateescu & Gröhbiel (2016)	Switzerland	Mobile learning	Systematic review
Cochrane (2014)	New Zealand	Web 2.0	Participatory action research
3.2.3 Hybrid learning contexts			
Mesh (2016)	Italy	The use of blended learning in university based language courses	Descriptive study including comparative data on student performance
Wanner & Palmer (2015)	Australia	Students and teachers' perceptions of a flipped classroom course including flexible assessment	Surveys and focus group interviews
Blau & Shamir-Inbal (2017)	Israel	Students perceptions of teaching and learning processes in a flipped learning course	Qualitative analysis of students' written reflections
Ali et al. (2017)	Korea	Development of a learning platform for flipped learning	Description of a learning platform

3.2.1 Lecture capture

Before presenting the three studies on lecture capture (Witton, 2017; Al-Nashash & Gunn, 2013; Hung et al., 2018) a brief background description and introduction to concepts is given.

According to Witton (2017), capture technologies are commonly referred to as *Lecture Capture*, and typically used to record lectures. It refers to a combination of software and hardware that will record any combination of audio, video, presentation slides etc. that can be viewed online, at any time, from any place and on any device. These terms are used in the capture technology research:

TERMS USED	EXAMPLE OF USAGE
Capture system	The system used to create and distribute recorded and live streamed video content.
Capture technologies	The capture system plus all devices associated with the capture process, including computers, cameras, microphones and mobile devices.
Captured content	Any learning content created and distributed using the capture system (e.g., recorded lectures).
Flipped classroom	Pre-recorded information viewed by students in advance, providing an opportunity for group-work.
Demonstrations	Pre-recorded demonstrations of activities viewed by students in advance (laboratory exercises etc).
Supplementary materials	Additional learning materials (e.g., short clips) created ad-hoc to enhance standard curriculum.
Assessment unpacking	The lecturer anonymizes students' questions and records a response for the whole group.
Capture on-location	Content is captured off-campus, such as fieldwork or examples from the workplace.

Most published studies on capture technologies have focused on the use and impact of recorded lectures, linking lecture capture with student satisfaction. The research shows that students adapt their use of the available captured content depending on their individual learning needs and that student learning increases when staff deliberately incorporate captured material into their overall educational approach[72]. While flipping the classroom can improve student performance[73], it does not always make students more satisfied[74]. Little or no research has shown positive impact on student attainment and a few studies report detrimental impact on academic performance resulting from the availability of recorded lectures[75].

Witton (2017) explores the use of capture technologies at the University of Wolverhampton, where an award- winning science center (the Rosalind Franklin Building) was designed with no traditional teaching spaces (no classrooms, no lecture theatre, no podiums, or projectors). Flipped classroom pedagogy influenced the design with the vision to facilitate active participation and all information delivery by video. Pre-recorded demonstrations allow students to prepare, reflect, and review before their laboratory sessions.

72 Marchand, J., Pearson, M., & Albon, S. (2014). Student and faculty member perspectives on lecture capture in pharmacy education. *American Journal of Pharmaceutical Education, 78*(4), Article 74, 1-7.

73 Baepler, P., Walker, J., & Driessen, M. (2014). It's not about seat time: blending, flipping and efficiency in active learning classrooms. *Computers & Education 78*, 227-236.

74 Missildine, K., Fountain, R., Summers, L., & Gosselin, K. (2013). Flipping the classroom to improve student performance and satisfaction. *Journal of Nursing Education, 52*(10), 597-599

75 Johnston, A., Massa, H., & Burne, T. (2013). Digital learning recording: a cautionary tale. *Nurse Education in Practice, 13*(1), 40-47.

A small-scale pilot collected just over 100 hours of content with over 1000 hours of viewing by students, and the usage figures revealed a large variance (2-4 hours of viewing for each hour recorded) in the amount of captured content viewed by students between different subject areas.

To evaluate the learning activities, a survey was distributed among 650 students (111 responded). All respondents wanted the university to continue with capture technologies and found all types of captured content helpful to their learning, with the pre-recorded demonstrations of practical science the most popular type of content. Student responses indicate that they value flexibility and playback control provided by captured materials, as this enhances concentration, improves understanding and increases confidence in their own learning. This conflicted with the analytics, which identified supplementary materials as the most viewed type of content.

Academic staff (13 of 62 responded) said they would like to make more use of the technology in the future. Main barriers to greater engagement was workload and lack of available time to capture new materials, but respondents agreed that captured content would ultimately save time. This new way of working required a shift in their focus during face-to-face sessions. Rather than concentrating on the *how to* of scientific techniques they were able to facilitate deeper learning by focusing on *why*. The evaluation of the pilot indicates that purposeful use of capture technologies leads to greater engagement with the types of captured content, which is likely to have a positive impact on student attainment.

Al-Nashash and Gunn (2013) investigated the use of webcast lectures among 40 students in two electrical engineering classes at a university in the United Arab Emirates. Every lecture was captured by the interactive eBeam whiteboard technology, consisting of a standard whiteboard, a data projector, a desktop, the eBeam edge transceiver and a stylus pen. The pen movement is transferred to the computer and sound recorded directly. The main disadvantage of the system is the inability to video record the instructor while lecturing.

Survey data (n= 38), focus group interview (n= 4) and statistics revealed that 37 out of 38 students either strongly agreed or agreed that the videos helped them understand the course material, and 34 of 38 thought having access to the video would raise their course grade. Most of the students regarded the video lectures, where they were freed from taking notes, as an additional learning tool, not as a replacement for the lecture. Data from the surveys and course management system reports indicate that students regularly view the course video contents. Peaks were observed prior to midterm exams. Even though the students did not see the lecturer, they still found the lecture capture helpful. Main drawback was associated with technical difficulties.

Hung, Kinshuk and Chen (2018) developed an embodied interactive video lecture (EIVL) with collective intelligence and natural user interface (NUI) technology, and evaluated the effects of the video lecture on learners' comprehension, retention and cognitive load of the learning content.

Collective intelligence (CI) draws on interactive learning activities and can generate valuable information for improving learning design. It aggregates interactions undertaken by groups of students who reflect, argue and debate in discussion forums, where knowledge grows over time and is considered a useful educational resource as it helps students comprehend the learning content from the perspective of many online students, who discuss as they watch the video lectures.

Interactive learning activities (ILAs) provide the learner content interaction through storyboard development, spoken scripts, pedagogical designs and creation of multimedia content and typically entail clicking on a mouse and typing with a keyboard. A new type of human-computer interface, natural user interface (NUI), allows students to directly interact with the learning content through the motion-sensing functionality of Kinect sensor instead of the mouse and keyboard options. The implementation of EIVL is guided by six scaffolding functions: recruitment, reduction in the degree of freedom, direction maintenance, marking critical features, frustration control and demonstration[76].

The content is generally recorded when instructors give on-site presentations and usually includes instructor`s voice, lecture slides, visual aids, multimedia materials, the lecturing environment and interaction with the on-site audience. In this study the CI content is categorised into four types; extended reading, reflection, hands-on practice, and discussion. Each type of the CI content reflects different levels of difficulty. To provide learner ILAs with constructive support, six types of interactive learning activities based on the six scaffolding functions are delivered (see table 4 below)

76 Wood, D., Bruner, J. S., & Ross, G. (1976). The role of tutoring in problem solving. *Journal of child psychology and psychiatry*, *17*(2), 89-100.

Table 4. Design of interactive learning activities for embodied interactive video lectures (Hung et al., 2018 p. 120)

INTERACTIVE LEARNING ACTIVITY	SCAFFOLDING FUNCTION	DESCRIPTION
Engaging	Recruitment	An instructor encourages the learner with a prologue, or an audience express motivation for the content. Then, the learner makes a simple response to the instructor or audience.
Prompting	Reduction in degrees of freedom	An audience actively asks the learner a question for reflection, and the learner has 30 s to think about it. Then the audience provides a thought related to the question.
Experiencing	Direction maintenance	The learner performs an exercise or a simple simulation related to the content with the guidance of an instructor
Facilitating	Marking critical features	An instructor provides crucial learning concepts to the learner, allowing the learner to strengthen the impression on the learning concept.
Demonstrating	Demonstration	An instructor provides an example, ideal case, or solution to interpret a learning concept, and the learner can have a better understanding of the learning concept.
Questioning	Frustration control	The learner can ask an instructor for assistance from a set of selected questions and receive a corresponding answer when being in trouble with a learning concept.

The study design includes embodied interactive video lecture (EIVL) with NUI technologies (experimental group A), non-embodied interactive video lecture, using the mouse to control the learning process (experiment group B) and conventional video lecture, learning content without interactivity (control group C). 90 students from a university in Taiwan were randomly assigned to the three groups.

A pre-test was adopted to measure students' language ability and prior knowledge. Two post-tests, to measure learning outcomes, took place immediately after the video lecture, and seven days later. To understand how interactive technologies influence learners, a cognitive load questionnaire was used as the self-reported measurement with 9-point Likert scale including two constructs (mental effort and perceived difficulty).

The pre-test showed no significant differences among the three groups for participants' prior knowledge. The post-test showed a significant difference for participants' comprehension depending on video lecture types. While the experimental group A outperformed control group C and experimental group B outperformed control group C, no significant differences were found between the two experimental groups. The delayed tests showed the same pattern as the post-test. There were no significant differences between the three groups for participants' overall cognitive load.

The post-test shows that EIVL significantly outperformed non-embodied IVL and conventional VL in comprehension, but no significant improvement was found between EIVL and non-embodied IVL. Findings suggest that embodied interactive video lecture provide learners with more learning cues and thus can help them improve their comprehension and benefit retention.

3.2.1 Lecture capture has shown inconsistent findings in the research on capture technologies. While researchers perceive capture technologies as a potentially productive learning design, research cannot establish positive outcomes. Students perceive captured content (webcasts, video lectures) as tools that improve their understanding of the course material. They believe that simply having access can raise their course grade and argue that all types of captured content are helpful to their learning. Analytics reveal, on the other hand, that most viewed type of content is supplementary material. This finding may indicate that students use captured material to broaden their understanding of the topic instead of taking the opportunity to *deepen* it.

3.2.2 Mobile learning

Three articles report from studies on mobile learning, and are presented here. Mobile learning has been defined as *the processes of coming to know through conversations across multiple contexts among people and personal interactive technologies*[77]. Mobile devices are considered cultural tools transforming socio-cultural practices and structures in all spheres of life[78], and the educational use of digital mobile technology is at the core of research labelled *mobile* and *ubiquitous* learning.

Dennen and Hao (2014) present the M-COPE framework for mobile learning in higher education, created to support academics who use devices and apps in their teaching. The framework was developed to visualise the systematic interplay of components in the mobile learning context, and to facilitate sound decision making at each step of the design process in both formal and informal mobile learning activities. Key mobile-specific considerations were extracted, reviewed across cases and grouped by topic. Framework validation occurred via a literature review and an expert review panel.

M-COPE focuses on design of mobile learning activities, both instructor-facilitated in formal or informal settings, and learner-initiated. Instructors are expected to consider five critical areas: Affordances of mobility, Conditions, Outcomes, Pedagogy and Ethics. The framework is flexible; readily integrated with established instructional design process models, and continuously prompts instructors to consider learning needs and constraints[79]. The model shows the M-Cope framework integrated with the generic instructional design model Addie (analysis, design, development, implementation and evaluation):

77 Sharples, M., Taylor, J., & Vavoula, G. (2007). A theory of learning for the mobile age. In R. Andrews, & C. Haythornthwaite (Eds.), The handbook of e-learning research. London: Sage.

78 Pachler, N., Bachmair, B., & Cook, J. (2010). *Mobile Learning: Structures, agency, practices*. New York, Dordrecht, Heidelberg, London: Springer.

79 The ADDIE model-Analysis, Design, Development, Implementation and Evaluation - is considered the generic or baseline instructional systems design (ISD) model. The model promotes a focus on five key processes during the larger process of instructional design.

Addie-model	M-Cope promting questions for each phase
Analysis phase	Mobile: How can MD enable learning interactions that are not otherwise possible in a specific environment/content area? Conditions: Learners prior experience with MD and ML Outcomes: Does learning objectives relate to MD? Pedagogy: Why will mobile activity support learning in a specific context? Ethics: Voluntary participants, internet safety, digital footprints?
Design phase	**Mobile**: Role of MD, elements of MD necessary to support LA, exisiting mobile tools used in the LA? **Conditions:** New or adopted mobile resources? One device for each learner? Learners own devices? Where and when does the LA take place? **Outcomes:** How will MD enable learners to meet learning objectives? **Pedagogy:** How does MD support instructional methods? **Ethics:** If «Bring your own device»-model is used, might anyone be left out?
Development phase	**Mobile:** Is the desired mobile functionality possible? **Conditions:** Functioning of mobile resources across platforms/ device types? **Outcomes:** Is activity aligned with learning outcomes? **Pedagogy:** Conflicts between desired methods and mobile functionality? **Ethics:** User friendliness and security of MD.
Implementation phase	**Mobile:** MD prepared for lessons? **Conditions:** Internett connection sufficient? **Outcomes:** Are learning support necessary to ensure learning outcomes met? **Pedagogy:** Facilitation of mobile interactions. Teacher actions necessary to ensure learning. **Ethics:** Digital footprints from learners? Learner access to technology needed? Learners negative emotions related to ML.
Evaluation phase	**Mobile:** Evaluation data collected automatically via MD? Did the MD and apps function well? **Conditions:** How did MD support learning? Learner attitudes? **Outcomes:** Anticipated outcomes achieved? Unanticipated outcomes? **Pedagogy:** Did MD enhance the learning experience? **Ethics:** Learners emotions related to use of MD. Treatment of data generated from ML activity.

M-Cope key elements	Overarching questions to consider
Mobile	What value does using a mobile device add to the learning context?
Condition	Learner preparedness, environmental suitability, time and disruption.
Outcome	Ensure that mobile use supports rather than detracts from meeting the objectives of an instructional design. Unintended outcomes important to consider.
Pedagogy	Specific instructional approaches may vary; active presentation, discussion, experiences, problem solving or simulations. The pedagogical method should be selected once the conditions and outcomes are known.
Ethics	Ownership of educational products (including archived conversations and social media contributions), occurring and the appropriateness of potentially ubiquitous and non-stop engagement. Device ownership. Challenges concerning digital footprints and stored data about learner performance.

MD: Mobile devices; ML: Mobile learning; LA: Learning activity

The M-COPE framework supports careful consideration of the conditions for learning, desired outcomes and pedagogical approach related to mobile technologies and potential ethical issues that arise in a mobile learning context.

Pimmer et al. (2016) conducted a systematic review of 36 papers published between 2000 and 2013 investigating mobile and ubiquitous learning designs. They identified a variety of educational designs, with *instructionism* as the most prevalent (22 studies), followed by *constructionist learning* (13) and *situated action* (12). A *hybrid* of situated, constructionist and collaborative designs characterised 6 studies.

Instructionism is rooted in behaviourism, teacher driven, prescriptive and focuses on the organisation of instruction[80]. Technology use means, in this tradition, using computers to instruct learners or having computers do the instruction. Three themes were detected in this category: 1) Ad-hoc and post-hoc transmission of lectures (e. g. Podcasts); 2) Supplementary study materials (provided to students' mobile devices) and 3) Activation and formative assessment (attempts to activate students during or after lectures). Studies showed, however, that students tended to postpone reading the items they received on their mobile devices and that podcasts were infrequently used. Studies on activation and formative assessment showed mixed results. In

80 Laurillard, D. (2009). The pedagogical challenges to collaborative technologies. *International Journal of Computer-Supported Collaborative Learning*, 4, 5-20.

general, the instructional design was grounded in rote learning and most studies measured the acquisition of simple items. Studies did not measure higher-level learning goals, such as deeper understanding, sense-making, or the application of knowledge to new situations. Positive knowledge gains were frequently explained by repetition.

Situated action designs facilitate inquiry-based learning and problem solving. Compared to the more teacher-guided instructionist design, situated action learning happen in authentic real-life situations. Poorly structured learning environments were supported by mobile devices, providing spatial, sequential, and cognitive scaffolds adapted to the learners' specific context, such as nursing and medical students using PDAs to access tools that facilitated informed decision-making in their work context. Studies with a situated action and scaffolding design had inconclusive results regarding learning outcome and conceptual understanding.

Constructionist learning design is centred on the idea that learning is a sense- or meaning-making process of knowledge construction and co-construction. Learning is a process of *making* something that *makes sense* in the real life of the learners (real objects or virtual entities)[81]. Studies included in the review found that the multimodal and communication capabilities of mobile devices support the construction, co-construction, and sharing of knowledge in the form of linguistic representations (written and recorded speech), and visual representations. Photographs taken with mobile devices, is mentioned as a valuable feature of this learning design.

Pimmer et al. (2016) found the hybrid studies to be the most convincing as they integrated situated and constructionist approaches, and connected them to the students' experiences in more formal learning environments. Assignments aimed to develop multimodal representations in situated, real-life learning environments enhanced the students' situated awareness, made them observe and reflect more consciously on their experiences; and connect their observations with concepts from formal education. Studies that involve hybridisation provided convincing arguments for what is viewed as the core of mobile learning: *the facilitation of learning across multiple contexts.*

Mobile learning can expand curricula by connecting learning in and outside higher education environments. For this to succeed, educators must develop extended learning designs that link different pedagogical strategies.

The review concludes that the hybridisation of situated, collaborative, and constructionist approaches via mobile devices can create new and unprecedented educational opportunities by connecting knowledge from formal learning settings with informal learning practices. These educational experiences then facilitate reflection and discussion in the classroom. The findings confirm previous reviews in which most studies of mobile and ubiquitous learning showed positive effects. As many mobile learning projects take instructionist approaches and many studies reveal that the traditional behavioural learning paradigm still dominates, the widely expressed expectation that mobile learning will transform higher education is unlikely to be fulfilled.

Cochrane (2014) presents findings from a longitudinal study investigating the potential of mobile web 2.0 tools to facilitate social constructivist learning[82] across multiple learning contexts. Participatory action research was used to investigate mobile learning (mlearning) projects from 2006 to 2011, aiming at pedagogical transformation. Data involved pre-project surveys, reflective blogs and eportofolios, followed by post project surveys and focus groups.

The project goal was to facilitate student-directed or negotiated learning. Learning activities and assessments were redesigned to facilitate student-generated content published in web 2.0 portfolios, with accounts created by each student who invited peers and lecturers into the collaborative spaces.

Four general pedagogical frameworks guided the design and implementation of the research: Communities of Practice, the Conversational Framework of Practice, Learner-Generated Contexts,

81 Papert, S., & Harel, I. (1991). Situating constructionism. In I. Harel, & S. Papert (Eds.), *Constructionism: Research reports and essays, 1985-1990.* Norwood, N.J: Ablex Publishing Corporation.

82 Social constructivist learning postulates that we learn most effectively by being actively involved in knowledge construction in groups with guidance from more knowledgeable peers (Cochrane, 2014).

and Authentic Learning. Data analysis of participant feedback, surveys, focus groups, and journals (blogs) from the mobile learning projects identified six pedagogical success factors crucial to enabling significant pedagogical change within a course:

1. How technology is pedagogically *integrated* into the course and assessment
2. Lecturer modelling of the pedagogical *use* of the tools
3. Creating a *supportive* learning community
4. *Appropriate* choice of mobile devices and web 2.0 social software
5. Technological and pedagogical *support*
6. *Sustained* interactions facilitate ontological shifts, both for lecturers and students

Crossing these critical success factors is the sixth factor *sustained interaction facilitating ontological shifts*[83]. Cochrane (2014) identified these shifts as necessary for significant pedagogical change: (1) Reconceptualising the role of the teacher (from content deliverer to facilitator of authentic experience), (2) Reconceptualising the role of the learner (from passive recipient to active co-constructor of knowledge), and (3) A radical conceptual shift in how we understand the affordances of mobile social media to augment traditional physical learning spaces and interaction.

Having compared previously identified success factors, the key contributions to mobile web 2.0 critical success factors identified by Cochrane (2014) include:

1. The need for technological and pedagogical support for matching the unique affordances of mobile web 2.0 with social constructivist learning paradigms.
2. The explicit scaffolding of the ontological shifts in pedagogical transformation via a structured and sustained intentional community of practice model over a significant period.

Cochrane (2014) concludes that the Communities of Practice model for supporting the mobile web 2.0 projects has led to the development of collaborative partnerships, resulting in increased student engagement, deeper pedagogical reflection, and practice-based research outputs.

3.2.2 Mobile learning has shown that for mobile learning to succeed, educators must create new and extended learning designs that link different pedagogical strategies. Mobile learning design must take into consideration expected outcome, context, desired pedagogy, ethics, and mobile-specific affordances. Important factors for sustained pedagogy in mobile learning are *integration*, *support*, *interactive use*, and *appropriate* choice of tools. Still, a behaviourist learning paradigm, where instruction is perceived as content delivery, seems to dominate higher education teaching practices, even in mobile learning environments.

3.2.3 Hybrid learning contexts

Four of the included studies investigated learning across contexts. Flipped classroom is a form of blended learning that can be defined as an educational technique consisting of: (1) active face-to-face classroom learning, most of the time in groups, and (2) online digital technologies and well-designed self-regulated, technology-assisted learning outside the classroom. In the flipped learning approach, direct instruction is delivered outside of the classroom, through digital tools, PowerPoint-presentations, videos of pre-recorded lectures and text, while class time is used for peer collaboration and instructor guidance.

Mesh (2016) describes the 10-year development of blended learning for English language classes at the University of Siena Language Centre. 21st century learning requires that students also learn soft skills, such as intercultural communication, presentation skills, and teamwork, in addition to acquiring language competence. The study employed a curriculum-based approach, where course content is developed through input from students and educators.

Over the years, the blended-learning design changed significantly. Courses were taken not only by university students but also adults, either in the form of self-study or blended learning. Thanks to a needs analysis, gradually more online activities were integrated into the course design, such as forum discussions, wikis, videos, and online assessment. After two years of using a digital workplace created

83 An ontological shift involves either a reassignment of understanding from one ontological category to another (radical conceptual change) or within a category (conceptual change) (Cochrane, 2014).

for collaborative knowledge building, a Moodle learning environment was adopted. The number of students grew from around 1,000 in 2005 to over 3,000 in 2015.

Data collected over one academic year (2014-2015) suggests that blended learning methods can be as effective, or even more, than traditional methods. However, blended learning is more effective when special attention is given to its course design. This conclusion was based on the comparison of blended learning and face-to-face learning groups on student retention (percentage of students who registered, but never attended a class) and academic performance (percentage of students that passed the exam).

Wanner and Palmer (2015) report from a flipped learning approach in an advanced undergraduate course where flexible assessment was introduced along with more choices and individualised submission dates for 109 students. Flexible assessment involved more learning-oriented assessment; assessment *as* and *for*, not just *of* learning. Students and teachers evaluated the approach through surveys and focus group interviews.

The study found that students want personalised learning with flexible assessment, not only in online activities, but also through interactive, collaborative, well-structured learning activities in face-to-face environments. This confirms previous research stating that students prefer a blended learning approach to fully online learning. Wanner and Palmer (2015) argue that how teachers design learning is crucial. Flexible and flipped learning requires institutional support and committed teachers, both in the process of designing, implementing and running a flipped learning course.

Blended learning challenges both teachers and students. Students should be self-motivated, well organised and independent, which is often unfamiliar for those used to traditional teaching. The study finds that students were concerned about technical issues, self-motivation, remembering to do course tasks, as well as additional workload and potential lack of direction. This adds to prior research showing the importance of encouraging student control over the learning process.

Longer face-to-face sessions in small group activities, set up by the teacher for interactive, collaborative learning benefits student engagement and learning experiences. When they had completed the learning modules, students felt better prepared for classroom activities.

There is limited evidence that flipped classroom and personalised learning leads to better grades and learning outcomes. In addition, there is little research on what level of control is beneficial for students, and at which level of flexibility higher education courses are effective in improving student engagement, experience, and learning outcomes.

Blau and Shamir-Inbal (2017) explore the core elements of a flipped learning design with self-regulated learning. The course builds on the holistic flipped classroom model[84] connecting the physical classroom and online synchronous and asynchronous environments that students can access from home or from mobile devices. This model shifts the focus from lectures to learning, emphasising which activities students should complete, and how activities should be delivered in class or at home.

The study involved 36 students who attended the course “Technologies and Learning Systems” at the Open University in Israel, largely based on teamwork, but also face-to-face, asynchronous and synchronous lessons. Students were required to learn independently or in small groups, while both time and place were flexible. The course website contained course readings and videos, guidelines for assignments, schedule, forums, links to collaborative documents, recorded lectures, recordings of synchronous lessons, presentation files, and learning outcomes shared by the students. Course content was open for editing, allowing students to share their insights and link to new information. Students discussed, in groups of three, various study topics through online discussion forums. Discussions were summed up in collaborative documents and students assessed their own and peers’ performance, following evaluation criteria developed for each course assignment.

The traditional flipped learning model uses technology at home as a channel for transmitting information to students, while in the classroom it applies a constructivist pedagogy without technology. The re-designed flipped learning model highlights the

84 Chen, Y., Wang, Y., & Chen, N. S. (2014). Is flip enough? Or should we use the flipped model instead? *Computers & Education*, 79, 16-27.

important role of digital tools in class activities. Technology was used to support learning on all levels including remembering, understanding, applying, analysing, evaluating, and creating (*cf*. Blooms taxonomy). Presentation apps enabled technology-enhanced collaborative learning activities in- and out-of-class. While e-accessibility of the learning content and active learning by individual students has become a common practice in higher education, Blau & Shamir-Inbal (2017) argues that co-creation of the course content by students and co-creation of learning outcomes by virtual teams of students remain rare, even though these activities benefit students' learning.

For flipped pedagogy to be successful, students must acquire strategies for self-regulated learning, co-regulation, and shared regulation. The re-designed model emphasises technology enhanced embedded assessment, were students develop self-regulation strategies as they co-create course content and individual reflections are combined with peer feedback. Based on study findings, a re-designed model of the holistic flipped classroom is suggested, that considers the *added value of technologies* in promoting higher order thinking skills during both in- and out-of-class learning. Five core competences for successful learning in digital environments were identified: *communication*, *collaboration*, *critical thinking*, *complex problem solving*, and *creativity*.

Ali et al. (2017) presents the architecture of the Internet-of-Things Flip Learning Platform (IoTFLiP). and the Interactive Case-Based Flip Learning Tool (ICBFLT), a tool that is already used in various medical applications. It provides students with virtual cases to solve and a working scenario for case-based learning by connecting devices in a network. The IoTFLIP was developed as an extension to ICBFLT to improve teaching and learning in medical education by working with real patient cases.

Pedagogical approaches used in this study are flipped learning (FL) and case-based learning (CBL), a form of small group learning, where students try to solve a case based on authentic data before learning the theory. CBL can be implemented in both clinical and non-clinical courses, and was successfully used as a basis of the medical curriculum at the University of Missouri. FL refers to a way to organise a course, where students attend face-to-face lectures, but some parts of the material are accessible online. IoTFLiP comprises a local block with four layers (Data Perception, Aggregation and Preprocessing, Local Security, and Access Technologies) and a cloud block with four layers (Cloud Security, Presentation, Application and Service, and Business Layer).

ICBFLT provides virtual cases for students to solve. The eight step working scenario is developed with medical experts, who interview patients to collect the data. The interview data is complemented by data collected from wearable devices. On this basis the expert builds scenarios for students to solve and get feedback from the expert. The main conclusion in this study is that there is a potential for a successful implementation of the platform.

The study identified three main research gaps: the need of combining CBL with FL, the potential of using IoT technology in medical education, and the potential of supporting CBL with IoT.

3.2.3 Hybrid learning contexts: Researchers have reported that both teachers and students are challenged when learning happens across contexts; face-to-face and technology enabled. Students are expected to develop a range of self-regulation strategies (goal setting, monitoring, time management and self-evaluation). Blended and hybrid learning requires increased time commitment from lecturers. A major issue in the studies is the need for institutional and technical support for staff. Research also shows that students appreciate the possibilities that hybrid learning formats offer and that blended learning is at least equal to traditional face-to-face teaching and learning in achieving student learning outcomes.

3.3 EMERGING EDUCATIONAL TECHNOLOGIES AND INNOVATIVE LEARNING

Ten of the included studies address questions of innovative learning practices, methods and devices, including Augmented Reality, games, interactive response systems, cloud pedagogy, virtual teaching methodology and pedagogical implications of emerging technologies.

AUTHOR	COUNTRY	HAVE INVESTIGATED	METHODS USED
3.3.1 Augmented Reality			
Wang (2017a)	Taiwan	Augmented Reality	Quasi-experimental design
Blanco-Fernandez et al. (2014)	Spain	Augmented Reality	Design study
3.3.2 Games and interactive response systems			
Lameras et al. (2017)	UK	The design and use of serious games	Evidence-based review and synthesis
Vlachopoulos & Maki (2017)	Cyprus	Games and simulations	Systematic literature review
Edmonds & Smith (2017)	Australia	Mobile learning games	Observations, surveys, focus groups, game analytics
Wang (2017b)	Taiwan	Interactive response systems, Kahoot	Controlled experiment
3.3.3. Pedagogical implications of technology use			
Jones & Bennett (2017)	Australia	The digital/non-digital binary	Theoretical
Barak (2017)	Israel	Cloud pedagogy, web 2.0 technology	Sequential explanatory mixed methods design
Ng'ambi (2013)	South-Africa	Emerging technologies	Survey and interviews
Van Es et al. (2016)	Australia	Cytopathology whole slide images and adaptive tutorials	Randomized crossover trial

3.3.1 Augmented Reality

Two articles (Wang, 2017a and Blanco-Fernandez et al., 2014) have focused on Augmented Reality (AR). Before presenting the studies, a brief background is provided[85]. Augmented Reality refers to technologies that project digital materials onto real world objects[86]; allow for interaction with 2D or 3D virtual objects integrated in a real-world environment[87], and enable the addition of missing information in real life by adding virtual objects to real scenes[88].

The term *Augmented Reality* was coined by Caudell and Mizell in 1992[89]. An AR system allows for seamlessly combining or supplementing real world objects with virtual objects or superimposed information. As a result, virtual objects seem to coexist in the same space with the real world and can be applied to seeing, hearing, touching, and smelling[90]. Augmented Reality research has matured to a level that applications can now be found in both mobile and non-mobile devices, and research finds that AR increases student motivation in the learning process[91].

85 From Jamali, S. S., Shiratuddin, M. F., & Wong, K. W. (2013). A review of augmented reality (AR) and mobile-augmented reality (mAR) technology: Learning in tertiary education. *International Journal of Learning in Higher Education*, *20*(2), 37-54.

86 Cuendet, S., Bonnard, Q., Do-Lenh, S., & Dillenbourg, P. (2013). Designing augmented reality for the classroom. *Computers & Education*, *68*, 557-569.

87 Dunleavy, M., Dede, C., & Mitchell, R. (2009). Affordances and limitations of immersive participatory augmented reality simulations for teaching and learning. *Journal of science Education and Technology*, *18*(1), 7-22.

88 El Sayed, N. A., Zayed, H. H., & Sharawy, M. I. (2011). ARSC: Augmented reality student card. *Computers & Education*, *56*(4), 1045-1061.

89 Caudell, T. P., & Mizell, D. W. (1992, January). Augmented reality: An application of heads-up display technology to manual manufacturing processes. In *System Sciences, 1992. Proceedings of the Twenty-Fifth Hawaii International Conference on* (Vol. 2, pp. 659-669). IEEE.

90 Azuma, R., Baillot, Y., Behringer, R., Feiner, S., Julier, S., & MacIntyre, B. (2001). Recent advances in augmented reality. *IEEE computer graphics and applications*, *21*(6), 34-47.

91 Bacca, J., Baldiris, S., Fabregat, R., & Graf, S. (2014). Augmented reality trends in education: a systematic review of research and applications. *Journal of Educational Technology & Society*, *17*(4), 133.

The cinematographer Morton Heilig developed the idea of the experience of multi-sensory immersiveness in 1950. He intended to immerse viewers with on-Screen activities by incorporating all the senses of the story into a viewer's real-world experience. In 1968, Ivan Sutherland invented the first Virtual Reality (VR) device – a head mounted display, The Sword of Damocles. Two years later he developed the first AR interface design system using an optical see-through HMD. The first system which allowed users to interact with virtual objects in a real-time application was an artificial laboratory called the Videoplace, developed in 1985. Mobile AR is a rapidly emerging research area and includes GPS tracking, user studies, visualisation, and collaborative applications. As a display technology m-AR could replace the HMD, binoculars, helmets, etc. There is a considerable amount of research published about Augmented Reality (AR) applications in educational contexts, but the field is still in its infancy; the potential of AR is being explored[92] and we are only beginning to understand characteristics of effective instructional designs for this emerging technology.

Wang (2017a) has integrated Augmented Reality (AR) techniques into a digital video course to investigate different learning effects for students using online- and AR-based blended learning strategies. In a quasi-experiment, 103 students from two classes were divided into one experimental group (N= 59) and one control group (N=54). The instructor designed and taught three learning topics over three weeks. The topics taught first and third (i.e., caption and subtitles, and special video effects) followed the original teaching method. The instructor first used PowerPoint, followed by a step-by-step software demonstration, and students then practiced. During the second topic, the teacher adopted PowerPoint for lecturing but integrated the AR-based contents for the experiment group and online-based contents for the control group to support their software practice.

Quantitative and qualitative data were collected through questionnaires, grades of weekly learning works, weekly learning diaries, self-evaluation scores, and video recordings of students' engagement during the practice sessions. Students uploaded their weekly work to the learning platform and the instructor evaluated the quality of their work and registered if the work was handed in on time.

Results showed an increase for both groups in the percentage of students handing in their work on time from week 1 to week 2 (when the AR-based and online-based blended learning strategies were adopted). After week three, when the learning supports were removed, the average grade of students in the experiment groups was slightly lower than those of the control group. The results also show that the AR-based blended learning environment enhanced the students' learning motivation. The online-based blended learning environment was useful for learning, but it did not prove to be helpful for sustaining learning motivation.

92 Chen, C. M., & Tsai, Y. N. (2012). Interactive augmented reality system for enhancing library instruction in elementary schools. *Computers & Education*, *59*(2), 638-652.

The students were positive about using the learning supports, and learning supports facilitated course discussion. Discussions differed in the two groups; the experiment group had lively discussions, with students exchanging experiences of how to succeed. Students in the experiment group had better learning interactions. The lecturer found the atmosphere in the classroom vivid, the room was vibrant with learning discussions, students moved around to check the learning progress with peers for further learning. In contrast, the control group was quiet, with the students concentrating on the online contents to complete the assigned work.

Some students in the experiment group felt busy and unfocused when they had to pay attention to the teacher's instruction and AR-based contents. Some had problems using the AR-based contents due to Internet connections, screen size of the devices, and limited affordances for AR interaction on mobile phones. The students preferred blended learning, and thus gave the online-based contents more positive feedback than the AR-based content. These findings support previous research arguing that the use of various learning media might not result in significant differences in educational outcomes, but that AR facilitates collaborative learning and peer discussions better than computer-based environments.

Blanco-Fernandez et al. (2014) presented REENACT, a project exploiting Augmented Reality (AR) technologies to improve the understanding of historical events with the aid of tactile mobile devices, repositories of multimedia contents, an advanced technological facility, and a remote expert.

REENACT is organized in three stages and allow participants to live the event from inside as reenactors, and from the outside, as historians. The study reports from a case where participants were invited to relive the Battle of Thermopylae (480 BC). Due to the re-enactment and the brainstorming driven by the expert, the participants said they had gained new perspectives on the Battle of Thermopylae.

STAGES	ACTIVITIES
Stage 1 (re-enactment)	Involving groups of people in the re-enactment of battles. They can physically move around in a room, playing the actions defined for a given role by a script of the historic event and interact with the other participants inside the game.
Stage 2 (replay)	The participants analyse what happened in a projection room. Having experienced the battle, with a partial vision, they now learn to watch things from outside, and see how their recreation compares to the real historic events.
Stage 3 (debate)	The expert drives a collective brainstorming about the consequences of the conflict in the short, medium and long terms.

The data analysis revealed the following benefits for the participants:

- Museum educators can invite participants to new types of collective experiences, supplementing the expertise and knowledge provided by experts.
- Museum visitors can enjoy new edutainment aimed at improved understanding of historic events, relying on social networking functionalities and Augmented Reality capabilities.
- Experts can collaborate with museum educators in new pedagogical settings.
- Content creators/providers can find an additional outlet for the multimedia contents they produce, which can provide historically-meaningful explanations to situations arisen during the re-enactments and to arguments raised in the debates.

Even though participants in the re-enactment of the Battle of Thermopylae were pleased with the experience, they usually asked for more videos and 3D views of the different locations of the game.

3.3.1 Research finds **Augmented Reality** to be a promising emerging technology with educational potential as it projects digital materials onto real-world objects, thereby allowing user interaction with virtual objects. AR enhances and expands students' learning experience as it facilitates collaboration, inspires and motivates students and supports student-active learning. Empirical research that confirms the manifestations of these expectations is, however, scarce.

3.3.2 Games and interactive response systems

This section presents four articles. Two reviews have examined the use of games in higher education; the design and use of serious games and the design, integration, and impact of games and simulations. One article reports from a project on mobile learning games and one article from a study of the interactive response system Kahoot!

Lameras et al. (2017) reviewed research on design and use of serious games (SG) in higher education, asking: 1) how is the use of games for teaching and learning conceptualised, theorised, modelled and researched? 2) what are the essential features of SGs in higher education, and 3) how do learning attributes match game elements as a means to optimise SG design and students' learning experiences? Included in the review are 165 papers reporting conceptual and empirical evidence on how university teachers may plan, design and implement learning attributes and game mechanics.

Serious games design is a relatively new discipline that couples learning design with game mechanics and logic. Designs for serious games involve creating learning activities that use the whole game or a gaming element (e.g., leader boards, virtual currencies, in-game hints) aiming at transforming the student`s learning experience. Serious games have been defined as: *a mental contest, played with a computer according to certain rules, that uses entertainment to further government or corporate training and education*[93]. SGs are appropriate for educational purposes as they discern learning theory, teaching and learning approaches, assessment and feedback. Some differentiate between entertaining and serious games, with SGs as more complex artefacts.

To link the entertainment aspect with learning features, two conceptual dimensions are suggested that allow students to expand their knowledge beyond the intended learning outcome set out by the teacher: *motivation* (e.g., playing the same level more than once) and *attention* (introduce new content along with in-game learning activities).

In games, tasks and activities are used synonymously, as tasks assigned by the teacher are transformed into student learning activities. Outputs of some activities are used as inputs to others, resulting in game flows that can be adapted while playing and learning. Learning activities encompass mental elements (e.g., to explore gravity by visiting virtual planets), game elements (e.g., a scoring mechanism) and physical elements (e.g., a scientific tool). The evidence whether or not SGs enhance student learning experiences is, however, inconclusive.

Meaningful *feedback* encourages students to reflect on misconceptions and transfer learning to new contexts. In games, the most common representation of feedback is through 1) progress bars, 2) in-game hints, 3) scoring, 4) achievements, 5) experience points, 6) virtual currencies, 7) prompts, 8) assessment tools, and 9) dashboards. Feedback is defined as a response to a learner`s performance against criteria of quality; and feedback progress indicators (FPI) show the current position of a student within a larger activity[94]. The SCAMP framework[95] is used for reviewing progress:

93 Zyda, M. (2005). From visual simulation to virtual reality to games. *Computer*, *38*(9), 25-32.

94 Gaved, M., Kukulska-Agnes, H., Jones, A., Scanlon, E., Dunwell, I., Lameras, P., et al. (2013). Creating coherent incidental learning journeys on mobile devices through feedback and progress indicators. Paper presented at the 12th World Conference on Mobile and Contextual Learning College of the North Atlantic, Doha, Qatar.

95 Jones, A., Gaved, M., Kukulska-Hulme, A., Scanlon, E., Pearson, C., Lameras, P., ... & Jones, J. (2014). Creating coherent incidental learning journeys on smartphones using feedback and progress indicators. *International Journal of Mobile and Blended Learning*, *6*(4), 75-92.

SCAMP-FRAMEWORK	
Social feedback	Embedded in game mechanics that indicate learning activity from students' interactions with: Non- Player Characteristics (NPCs), peers or teachers involved in playing simultaneously.
Cognitive feedback	E.g., formative feedback provided by the system, focusing on accuracy of understanding and correcting misconceptions.
Affective feedback	Attitudes and moods, feelings and emotions (e.g., game gifts such as extra characters, apparels and objects for enhancing motivation).
Motivational feedback	Aims to trigger students' curiosity to start playing the game and maintain student`s curiosity, attention and involvement by balancing fun (game mechanics) with learning elements to achieve engagement.
Progress feedback	Captures students' increased competence towards mastery: The performance of in-game learning tasks and the transfer of the knowledge gained to realistic contexts.

It could be assumed that game design influences how teachers act. Teachers must support and guide students who fail to see how to proceed to the next level by actively explaining rules, objectives, and learning outcomes, and provide game-play directions or observe student`s actions during the game. Teachers must, however, be aware of, and be responsive to potential frustration of students who struggle with complex or ill-defined game activities.

Games are structured through emergence and progression. *Emergence* is a game structure, specified as a small number of rules that combine large numbers of game variations for which the players must design strategies to handle. *Progression* is where the player must perform a predefined set of actions to complete the game. The game designer has control over the sequence of events, and games with strong storytelling features are dominant as progression games. It is generally assumed that games should be goal directed, competitive, and designed within a framework of choices and feedback to enable teachers and students to monitor progress towards the goal. Goals should be communicated by game attributes such as a score mechanism or a puzzle to resolve, which adds a competitive dimension to the design.

A classification is developed as a research instrument, providing guidance and support, and may be used by game practitioners or game science researchers who intend to plan, design, and develop a serious game or a SGs authoring environment for delivering a particular topic or lesson at any scale. This classification is shown in Table 5, below:

Table 5. Linking learning, game attributes, outcomes, feedback and teacher activities (Lameras et al. 2017, p. 987)

LEARNING ATTRIBUTE	GAME ATTRIBUTES	OUTCOMES	FEEDBACK/ ASSESSMENT	TEACHER ACTIVITY
Information transmission (teacher led) (Lecture, memorising concepts, labelling diagrams and concepts, exampling, incomplete statements, lecture summary, listening)	Task description; choices, content description, challenge repetition, scoring	Remembering	Progress; affect Summative	Designer/ evaluator
Individual (teacher and student led) (web-quest, exercise solving, carrying out scientific experiments, reflection, simulations, modelling, role playing, inquiry – pose questions, determining evidence, analysing evidence, formulating evidence, connect explanations to knowledge)	Game journal, missions, objective cards, storytelling, dialogues, puzzles, branch tasks, research points, study requirements, game levels	Understanding, analysing	Motivational; progress, affect formative and/or summative	Player, facilitator, designer, motivator, evaluator
Collaborative (teacher and student led) (Brainstorming, group projects, group web-quests, rank and report, group of students posing questions to each other, group simulations, pair-problem solving, group data gathering, group data analysis, group reflection)	Role-playing, community collaboration, epic meaning, bonuses, contest, scoring, timers, coins, inventories, leader boards, communal discovery, game levels	Applying analysis, evaluating, creating	Motivational, social formative and/or summative	Player, facilitator, motivator
Discussion and argumentation (Reflection) (Guided discussions – topic provided by teacher, open discussions – topics provided by students, choices: data on events and several choices for students to make comments, debates – justifying explanations)	Nested dialogues, NPC interaction, in-game chats; game levels, research track, maps, progress trees	Evaluating, understanding, analysis	Motivational, affective, social formative	Motivator, evaluator, facilitator

Most reviewed papers showed that the integration of learning elements into the design of a game creates misconceptions, discrepancies, and uncertainty in terms of how learning activities, feedback, and assessment may be used. How teachers should guide the learning of gaming students is fuzzy and unclear. To link teacher activities to the game elements and students' learning experience is imperative to the advancements of the field and it is central that teachers interact with students who construct in-game learning experiences. How feedback is designed and realised in the game play is key for the learning experience and outcome.

Vlachopoulos and Makri (2017) identified seven types of games: *action games*, *adventure games*, *fighting games*, *role-playing games*, *simulations*, *sports games,* and *strategy games*. The systematic literature review examined the design, integration, and impact of games and simulations in higher education with the goal to find the best practices and build a framework that can help educators to include games in their own practice to support their pedagogical approach and teaching objectives.

123 papers were included in the review. The two most popular genres of games were virtual/online games/ simulation (88%) and simulation games (42%). The subject with the largest number of studies was Business Management and Marketing, followed by Biology/Health, and Computer Science. The impact of games and simulations was divided into three groups: cognitive outcomes, behavioural outcomes, and affective outcomes. Findings were compared to the synthesized results from previous literature reviews and meta-analyses.

Findings indicate positive impact of games and simulations on cognitive learning outcomes including knowledge acquisition, conceptual application, content understanding and action-directed learning. It is, however, noted that learners' positive outcomes are dependent on what teachers do, such as setting achievable learning goals, interacting with students, promoting knowledge, supporting, facilitating, and motivating them to construct new game-based knowledge.

The review's main findings, divided by type of learning outcome, is summed up here:

TYPE OF LEARNING OUTCOME	FINDINGS	LIMITATIONS
Cognitive outcomes:	**Knowledge acquisition:** Games and simulations can support action-directed learning and deepen the understanding of theoretical concepts. **Perceptual skills**: Games and simulations can help learners develop complex cognitive skills, such as problem-solving, decision-making, and critical thinking.	There is mixed evidence on the performance improving effect of games and simulations compared to other methods. Even though teachers could also benefit from integrating games and simulations in their teaching, there seems to be a disconnect between games and curriculum, which highlights the important role of the faculty in technology.
Behavioural outcomes:	There seems to be an overall positive influence of games and simulations on collaborative learning and interaction, with a confirmed positive effect on behavioural outcomes, such as the development of social, emotional, and collaborative skills; helping students build strong relationship with peers; collaborate and work in groups more efficiently; become organized; adapt to new tasks; resolve emerging conflicts.	It is more beneficial to play individually than in groups. Collaborative playing was seen as a distraction to achieving learning objectives. Games gave students fewer opportunities to interact with other learners and the teacher.
Affective outcomes:	Most studies found that games and simulations had a positive effect on learners' motivation and engagement. Affective outcomes include motivational and engagement outcomes, emotional development, satisfaction, self-assessment, attitude, emotion, and self-efficacy.	Exceptions show that games and simulations are no more motivating than other learning methods. Significant financial barriers (design and development of games and simulations) must be taken into consideration.

Edmonds and Smith (2017) investigated students' educational benefits of playing location-based mobile learning games (LBMLG) on engagement, motivation and learning, and how the design of LBMLG promoted their educational experiences. Two approaches were used: learning by playing a LBMLG (Study 1) and learning by designing a LBMLG (Study 2). In the first approach, games were developed for undergraduate courses, in four discipline areas, introduced during lectures, and played by students during a tutorial, as a self-guided activity or field excursion. In the second approach, students designed and developed their own prototype games to explore pedagogical strategies in personalised learning. Students were observed as they played and designed games. Online surveys, focus groups, and game analytics were used to understand player behaviour, satisfaction rates, engagement, and the impact on learning outcomes. Data was collected over a period of 3 years.

Findings suggest that playing LBMLG enhanced students' educational experiences. They enjoyed the authenticity of real world learning (85%) and considered the game a fun way to learn (85%). They also agreed that the LBMLG helped them to learn more (67%), motivated them to do research (54%), or gave opportunities to practice different skills (61%). Most participants agreed that designing and developing a mobile game was engaging (84 %) cooperative (84%) and a fun way to learn (76%). Most of them asserted that developing a game gave them opportunity to practice different skills (84%) and implement their own ideas (84%).

The study concluded that both playing and designing LBMLGs can provide benefits by delivering active, engaging, and authentic educational experiences, which enhance the opportunities to interact with locations, online content, and with each other. Designing LBMLGs offers students an opportunity to develop research skills (e.g., managing, operating, and applying ICT) as they conceptualise, develop, and implement their own ideas.

Wang (2017b) conducted a quasi-experimental study in a course using an IRS (Interactive Response System) developed by Kahoot! from NTNU[96]. Kahoot! allows the instructor to create quizzes, discussions, and surveys and can be used by any device with a web browser. A quiz is projected on a canvas or screen in a

classroom, and students can join the quiz with their personal devices. Kahoot! uses multiple choice questions, answered in real-time with the participants competing to achieve the highest score. Given it is correct, the fastest answer collects the most points, and as soon as every participant has submitted a response, scores appear on the screen. The IRS is intended to interactively engage the students by emphasising elements of fun and play. In addition, the platform provides the teacher with a greater understanding of the students' current knowledge.

The experiment lasted 15 weeks, with 88 participating information and management majors from a college in Taiwan. In the experimental group, 44 students (14 females and 30 males) used a *learner as leader* strategy, meaning that the students played the role of leaders by taking turns hosting the IRS activities. In the control group, 44 students (6 females and 38 males) learned with a *teacher leader* strategy, where the teacher designed questions and items and administered the IRS activity every two weeks. To explore how the two strategies facilitated learning and whether it contributed to the students' self-regulated learning, questionnaire surveys were administered at the beginning, in the middle and after the experiment. The students were also asked to record their learning reflections in a weekly diary. IRS formative tests were conducted every one or two weeks, and test results were recorded for further analysis.

The experiment shows that using IRS in course teaching and learning not only facilitated interaction between teachers, students and peers, but also enhanced their motivation to learn the target subject and promoted learners' self-directed motivation. The

96 Norwegian University of Technology and Science

IRS keeps students alert and focused on what is being taught during lectures. The competitive factor triggers students to read the textbooks before class in order perform better and to correctly answer the questions raised by the teacher or peers. In addition, students showed initiative in reviewing their learning performance and scheduling learning progress after each IRS activity. No significant gender differences were found, with both male and female students expressing positive feedback on using the IRS for learning.

The data analysis found that using both teaching strategies with the IRS activity had positive effects on the students' learning. However, using the learner as leader strategy promoted students' learning interest more quickly than with the instructor as leader strategy. The learner as leader strategy promoted interaction between the teacher and peers and enhanced discussion in groups, especially for the leading groups. The use of the IRS with the learner as leader strategy benefited those who acted as leaders in taking the initiative to learn the content, while also engaging the students because the leaders of the course were their classmates – not the teacher.

3.3.2. Games and interactive response systems has shown that games must be goal directed, competitive, and designed within a framework of choices and feedback to enable teachers and students to monitor learning progress. For games to support students' learning, teachers must provide meaningful feedback at all stages and assist students. How feedback is designed and performed is key for students' learning experience and outcome. Teachers must be aware of and responsive to potential frustration of students who struggle with complex or ill-defined game activities. Playing and designing games can contribute to active, engaging, and authentic educational experiences. The IRS *Kahoot!* is found to keep students alert and focused on what is being taught during lectures and triggers students to read textbooks before class. The evidence whether serious games enhance student learning is inconclusive.

3.3.3 Pedagogical implications of technology use

Increasingly researchers argue that the successful use of technology in education is a question of pedagogy, rather than technology. When new, digital tools are introduced in higher education, they tend to be adapted to traditional practices, instead of contributing to innovations. Four studies have investigated this paradox, and find that while academics need technological know-how and support, professional training courses should emphasise pedagogy over technology.

Jones and Bennett (2017) argued that the contemporary (binary) discourse positions *digital* as new, modern, superior, representing the future; while *non-digital* is the past. The dichotomy *digital-future* versus *non-digital past* makes non-digital teaching and learning practices appear outdated, instead of co-existing. The authors' concern is that this binary thinking prioritises digital over non-digital and that in the rush to digitise higher education, best-practice teaching and learning based on sound pedagogy may suffer. The dichotomy digital/non-digital tends to overshadow the fact that *pedagogical quality* is the most important issue in both modes of educational provision.

Using Deleuze and Guattari's image of the non-hierarchical *rhizome*[97] (a space of interconnected possibilities, likened to a tree with roots and branches), the article proposes to see the course as an *ecosystem*, with several coexisting learning habitats[98], to promote optimal engagement for students with differing needs. While a university course has a (pre-defined) clear purpose, a fixed set of content, activities, assessment standards etc., and a series of expected learning outcomes, the rhizome should be perceived as a complex map of non-linear and non-hierarchical intersections, with the capacity to foster student engagement. The use of ecological (instead of technological) metaphors in course design is intended to re-empower university teachers to trust their experience, activate their creativity and make pedagogically driven decisions.

Barak (2017) has studied how teachers integrate web-based technologies and their perceptions of *cloud pedagogy* (an instructional framework to promote social constructivist learning)[99].

97 Deleuze, G., & Guattari, F. (1987). A thousand plateaus: Capitalism & schizophrenia. Minnesota, MN: University of Minnesota.

98 Wenger, E., White, N., & Smith, J. D. (2009). *Digital habitats: Stewarding technology for communities*. CPsquare.

99 Barak (2017) describes social constructivism as a learning theory contending that cognitive development is a social, meaningful process derived from communication with people or from the use of mediators.

STUDY OVERVIEW	PARTICIPANTS' WORK SITUATION	PARTICIPANTS' BACKGROUND AND DIGITAL COMPETENCE
First group of participants (responded to a survey)	48 university teachers teaching subject-matter courses or teaching methods courses.	A range of disciplines, varied digital expertise.
Second group of participants (written reflections and interviews)	73 pre-service science teachers attending a course focusing on methods of teaching science and technology.	The course implemented the *cloud pedagogy framework* that utilizes digital technologies to promote social constructivist learning.

The cloud pedagogy framework facilitates individual and collaborative, synchronous and asynchronous active learning, in class and outdoors. Cloud pedagogy includes a social constructivism layer and a techno-instructional layer. The social constructivism layer includes: (1) *exploring new venues* – learning by investigating and discovering scientific principles; (2) *co-constructing contents* – learning in teams; (3) providing and receiving feedback; and (4) *increasing engagement* – learning by interacting with peers. The techno-instructional layer included studio-based instruction[100], embedded assessment linking formative and summative evaluations to learning activities and cloud applications.

Barak (2017) found that university teachers still adhere to traditional, lecture-based teaching, typically through learning management systems and mainly to distribute learning materials or information. The study revealed a paradox. While university lecturers expect their student teachers to use advanced pedagogy and technologies in their future school teaching activities, they do not themselves provide sufficient examples for such practices when educating teachers. Many university teachers were not up to date with web 2.0 environments, such as Wikis, blogs, social networks, or other cloud technologies, and rarely used them when teaching. The potential in online technologies to facilitate social constructivist practices (small group discourse, collaborative authoring, online peer assessment, and social network), was not utilized. The survey data indicated a need for professional development activities that can support the implementation of web-based technologies, student-centred instruction and social constructivist learning.

Ng'ambi (2013) has investigated technology use and efforts to improve teaching and learning in higher education. A survey was sent to academics and support staff in 22 public Higer Education Institutions in South Africa. The survey had 30 questions exploring technology use, innovative practices, the reasons for use, the effects on teaching and learning, constraints and support from the institution. Members of the research team identified respondents, specifically targeted for their reputation as early adopters of new technologies, including lecturers, support staff, directors of teaching and learning and senior academics. 262 educators responded to the survey, and 18 were selected for an in-depth analysis.

Respondents were asked to list technologies they had *not* heard about. Most had never used remote instrumentation (85%), tablet computers (76%), web conferencing (66%), argumentation visualisation (27%), reusable learning objects (23%) and RSS feed (13%). The most frequently used was Learning Management System (24%) followed by blogging (8%), pod-/vodcasting (8%) and microblogging (3%). Educators primarily used emerging technologies (ETs) to support prescriptive practices and only a few reported on how technology use was changing their practice.

Ng'ambi (2013) argues that deep and meaningful learning can only be achieved with the effective pedagogical uses of ETs, and proposes Cultural-Historical Activity Theory (CHAT) as an analytical framework. In CHAT, Educational goals are defined (step 1), the relational agency (step 2) makes explicit assumptions about learning, distributed intelligence/expertise (step 3) describes the object of the activity, a learning activity is shaped by an awareness of capabilities of available technologies (step 4), appropriate tools are chosen (step 5), students create an artefact (step 6) and reflect on their learning experience (step 7). The paper concludes that the

100 A teaching method consisting of sessions combined with longer periods of active learning

proposed framework would serve as a guide to effective pedagogical uses of emerging technologies.

Van Es et al. (2016) has conducted an empirical study to determine the effectiveness of the virtual microscopy adaptive tutorials (VMATs) and whole slide images (WSI) to learn diagnostic cytopathology; a form of clinical decision-making, where the diagnosis is based on the study of cells. Even though it is an important part of professional everyday medical practice, this subject is rarely taught in medical education.

The aim of WSI is to imitate traditional microscopy in a digital environment. VMATs are interactive online tutorials developed using the Adaptive e-Learning Platform, an intelligent tutoring system providing individual students with adaptive feedback. Previous research conducted with pathology specialist trainees indicates that VMATs are perceived more positively than traditional learning methods. 35 senior medical students with no previous experience with cytopathology participated in the randomized crossover trial. They were divided into two groups of 17 and 18. The trial included three weeks of classes, each concluded with an online assessment with only one attempt and one-hour exam time. Each assessment question was linked to a WSI and evaluated either on the diagnosis or on identification of cellular features. Other data sources were students' self-reported study time, prior academic performance, and the results of online surveys evaluating user experience with WSI and VMATs and their value as educational tools.

There was no significant difference in the mean self-reported study time and in the prior academic performance (measured by the mean weighted average mark) between the groups. Student's t-test was used to analyse the online assessment results. The group using WSI and WMAT had higher scores percentage-wise in both FNA Cytology Assessment (after Week 2) and Fluid Cytology Assessment (after Week 3), but only the result for Diagnosis in FNA Cytology Assessment was statistically significant. This indicates that VMATs and WSI could be more effective than traditional approaches. Online surveys revealed that students preferred VMATs and WSI over traditional methods, suggesting more adaptive features are favoured. At the same time, they had a significant preference for VMATs than WSI alone. VMATs were evaluated as "more useful in developing

skills in cytopathology (...) more time efficient (...) and providing more equitable opportunities" (p.5). In comparison to WSI alone, VMATs enriched the learning environment with immediate feedback and interactivity. This adaptive approach embeds the tutor in the tool and is promising.

3.3.3 Pedagogical implications of technology indicated that introducing new technology does not, in itself, guarantee innovative practices in higher education institutions. Studies find that prescriptive practices persist. Instead of taking the opportunity to introduce student centred teaching methods, staff tend to adapt new technologies to traditional practice. If the introduction of technology in higher education teaching aims at more student active learning, institutions must develop policies for how they want to educate young technology users, lead and closely follow the implementation of the policies. The dichotomy digital/non-digital should not overshadow the fact that *pedagogical quality* is the most important issue in both modes of educational provision.

The following chapters 3.4 and 3.5 present two themes that are also crossing through all the included studies: *collaborative learning* and *barriers to technology use and innovative teaching.*

3.4 COLLABORATIVE LEARNING

Digital age learners are used to networking and expect modern higher education institutions to be on top of the digital development. Research, however, finds a gap between students' expectations and academic digital use and expertise. It is argued that institutions must develop visions and policies, prioritise and initiate institution-wide competence development to provide academics with the adequate competence and skills needed to utilise possibilities in new technologies.

This chapter presents five studies on collaborative learning approaches in online learning and teaching. First, a study in the CSCL-tradition investigates how conversational *agents* may promote academically productive talk. The second study provides an overview of modalities and practices in telecollaboration, and the third identify factors that promote and hinder technology use in higher education. Lastly, two studies have investigated social learning practices in apps and wikis.

AUTHOR	COUNTRY	HAVE INVESTIGATED	METHODS USED
Tegos et al. (2016)	Greece/Denmark/ Germany	Academically productive talk	Pre-test, post-test experimental design
Akiyama & Cunningham (2018)	USA	Telecollaboration	Scoping review
Newland & Byles (2014)	UK	Web 2.0 (Wikis)	Interview
Rambe & Bere (2013)	South-Africa	What`s App	Questionnaire and qualitative data
Zheng et al. (2015)	USA	Wikis and collaborative learning	Surveys, documents and qualitative data

Research in computer-supported collaborative learning (CSCL) has emphasised the importance of dialogical interactions among learners[101]. Depth and quality of peer interactions, in conflict resolution, mutual regulation or explicit argumentation, is found to play a catalytic role in how students comprehend the topic in question and learn from collaborative activities[102]. Despite this insight, research also finds that student dialogues are often unproductive[103]. Simply placing students together to discuss a topic does not ensure their engagement in effective collaborative behaviour[104]. This directs the attention to how CSCL environments can be designed to provide scaffolding during group discussions[105].

Tegos et al. (2016) drew on research indicating the effectiveness of flexible *conversational agents* in productive online peer dialogue. A conversational agent is a third-party intervener in an online dialogue, serving as an *attention*-grabbing strategy to keep students focused on task. A configurable APT-agent was used to prompt peers in online discussions to build on prior knowledge and logically connect their contributions to domain concepts that would support their claims and arguments. APT prioritises students' reasoning and does not expect the teacher to maintain complete control over student discussions. APT aims to orchestrate a more student-centred discussion, where students are motivated and challenged to think profoundly and use their scientific reasoning skills to solve problems. APT assumes that knowledge is constructed during peer interaction through a series of steps where learners' mental models are explicitly shared, mutually examined and possibly integrated[106]. The article reports from a pre-test post-test experimental design study, involving 96 computer science students, comparing three conditions:

101 Stahl, G., Cress, U., Ludvigsen, S., & Law, N. (2014). Dialogic foundations of CSCL. *International Journal of Computer-Supported Collaborative Learning*, *9*(2), 117-125.

102 Asterhan, C. S., & Schwarz, B. B. (2016). Argumentation for learning: Well-trodden paths and unexplored territories. *Educational Psychologist*, *51*(2), 164-187.

103 Dillenbourg, P., & Tchounikine, P. (2007). Flexibility in macro-scripts for computer-supported collaborative learning. *Journal of computer assisted learning*, *23*(1), 1-13.

104 Vogel, F., Wecker, C., Kollar, I., & Fischer, F. (2017). Socio-cognitive scaffolding with computer-supported collaboration scripts: A meta-analysis. *Educational Psychology Review*, *29*(3), 477-511.

105 Ludvigsen, S., & Mørch, A. (2010). Computer-supported collaborative learning: Basic concepts, multiple perspectives, and emerging trends. *The international encyclopedia of education*, *5*, 290-296.

106 Stahl, G., & Rosé, C. P. (2011). Group cognition in online teams. *Theories of team cognition: Cross-disciplinary perspectives. New York, NY: Routledge/Taylor & Francis. Web: http://GerryStahl. net/pub/gcot. pdf.*

PRE-TEST PHASE	COLLABORATIVE ACTIVITY	POST-TEST PHASE
Students individually answer a pre-test	Students discuss in dyads *No agent* intervention (Control) *U agent* intervention (U-treatment)* *D agent* intervention (D-treatment)**	Students individually answer a post-test; answer a student opinion questionnaire and participate in a focus group session

*U agent intervention: *Undirected* BPK (Building-on-Prior-Knowledge) interventions while collaboration in dyads (U-treatment condition)
**D agent intervention: Directed BPK interventions (D-treatment conditions)

Students who interacted with the conversational agent in the two treatment conditions (U and D) came out of the collaborative activity with a domain knowledge advantage over the students in the control group. Students in the control group (no agent intervention) perceived the collaborative activity as *less* helpful for enhancing their domain knowledge than the treatment students.

The analysis revealed that agent interventions had a significant effect on the levels of explicit reasoning exhibited during the collaborative activity. The frequencies of explicit arguments were substantially higher in the treatment group where students were pressed for clear statements backed by concrete evidence. This confirms other studies showing that an agent prompting students to follow academically productive practices can amplify students' scientific reasoning[107].

The agent also had a positive impact on dyad performance in the task. The dyads in treatment groups (U and D) provided more comprehensive and accurate answers to the learning questions. Overall, the conversational agent, committed to getting the facts right, seemed to play a critical role by asking students to consider themselves responsible for the accuracy and validity of their claims. Encouraging students to make their knowledge sources explicit is considered vital in academic settings for increasing collective reasoning levels and improving collaborative learning outcomes.

Students in the D condition appeared to be feeling personally responsible for giving a comprehensive response to the agent. The agent impact on individual learning appears to be amplified when the agent employs a directed intervention method targeting a particular peer, rather than an undirected intervention method, addressing both peers in a dyad simultaneously. Researchers reported that directing prompts to individual learners by an agent seems to be a feasible way to reduce diffusion of responsibility and facilitate equal participation in reasoning processes.

Akiyama & Cunningham (2018) have conducted a scoping review of 55 telecollaboration (TC) projects, with the aim to identify pedagogical practices commonly used in telecollaboration, defined as institutionalised, electronically mediated intercultural communication under the guidance of a teacher. TC has utilised asynchronous tools (email, bulletin board/ online forums, blogs) and synchronous tools, (videoconferencing, Skype, MSN Messenger). The review aimed to identify the most commonly used tools in telecollaboration projects in university foreign language classes and how tools have changed over the last 20 years.

Most projects were either mono- or bilingual. Email was used as the main tool of interaction; to find time for meetings, and to reinforce feedback by combining synchronous and asynchronous feedback.

107 Dyke, G., Adamson, D., Howley, I., & Rosé, C. P. (2013). Enhancing scientific reasoning and discussion with conversational agents. *IEEE Transactions on Learning Technologies*, *6*(3), 240-247.

DEMOGRAPHICS	PROJECT CHARACTERISTICS	PEDAGOGY
113 cultural groups from 25 countries were identified	The average duration of a project was about 10,54 weeks.	Five types of interaction formation when participants engage synchronously was identified: 1) 1-1, 2) 1-2, 3) small groups, 4) mid-size group 5) class vs class.
The majority of the participants were intermediate (n=29) or above intermediate (n=23)	About 60% of projects included asynchronous interaction in addition to synchronous while the rest only used synchronous.	Many projects were text-based (k=23) or combined text chat with video interaction (k=12). Projects also video chat only, audio chat, audio graphic and both audio and video chat.
	62% of messages was via e-mail, 16% via blogs, 14% via Wikis or websites, and 11% via discussion forums. Only one study used Facebook.	Most studies used information exchange tasks, and language-focused tasks were the least common. Twelve projects used co-construction tasks.

Six typical arrangements of synchronous telecollaboration projects were identified (Akiyama & Cunningham, 2018, p. 63-64):

1. *Tandem*: a synchronous session is divided into two parts (English 30 min, German 30 min).
2. *Socialisation:* Languages are kept distinct, sessions are synchronous (one session in English, the next in German).
3. *Co-construction*: engage participants in creating artefact (blogs, presentations). Co-construction usually has no strict rules for language separation or for how often participants need to interact as long as they create a cultural product.
4. *Apprenticeship*: the exchange takes place between FL learners and teacher trainees. One group is learning how to teach their partners TL. The interaction is usually monolingual.
5. *Cultural Exploration*: interaction takes place monolingually in FL learners` TL. The partner group`s main objective for participating is to increase familiarity with the target culture rather than language learning or teaching.
6. *Lingua Franca*: monolingual arrangement, but the language of interaction is none of the participants' first language. Emphasizes content learning over language learning and involves dialogue about political issues and acquisition of sociological knowledge.

Tandem has been and is the most popular arrangement, more recent studies tend to belong to Apprenticeship, Cultural Exploration or Lingua Franca. This indicates that there is now a wider range of partners who participate in TC for various purposes other than language learning.

Newland & Byles (2014) have investigated how eLearning with eResources (eRes) encouraged academics to use web 2.0 technologies. Data were collected through interviews with teachers in physiotherapy, midwifery, archaeology, marketing and design engineering. The table below shows e-resources used and learning activity in each course. Academics were interviewed individually about their experience with the project both during and at the end of the project.

PEDAGOGY	E-RESOURCE	LEARNING ACTIVITY	SUBJECT
Collaborative learning/ social construction of knowledge	e-Journals, blogs	Finding and critiquing articles using a blog	Physiotherapy
	Blackboard, scholar	Sharing using social bookmarking	Midwifery
	Wikis	Creating group based resources	Archaeology
Critical thinking	e-Journals, e-news	Critiquing and finding with timed use of blogs	Marketing
Problem-based learning	e-journals, blogs, wikis	Developing solutions in groups using blogs and wikis	Design engineering

The study shows that academic teaching can be changed with Web 2.0 technologies. Two issues were identified: (a) *scalability*: Most academics required a high level of support from pedagogical and technical specialists, and b) *professional development*: academics acknowledged their professional development requirements in relation to technology, but not the need to change their pedagogical approach. As Web 2.0 tools (i.e., blogs, wikis) are integrated in the institutions' LMS, students and staff have easy access to Web 2.0 tools. When academics hesitate to introduce Web 2.0 in their teaching, it is because it requires a different pedagogical approach. The authors ask if academics do not take ownership of their professional development and responsibility for their learning, but expect external initiatives and support.

Rambe & Bere (2013) report from a study using WhatsApp in an information technology course at a South African university. They argue that mobile messaging (MIM) is qualitatively and visually distinct from email systems and has the potential to create dialogic spaces for students and trigger academic participation. MIM is one of the least exploited functionalities of mobile devices in higher education and there is little research on how MIM influences pedagogy, for instance lecturers' instruction and students' academic participation.

A case study was conducted with 95 third-year technology students (59 female and 36 male) with a diverse language background[108]. The lecturer introduced WhatsApp to boost participation, and interaction lasted for a semester. WhatsApp did not replace teaching activities, but served to extend academic consultation during and after hours. The students were grouped in 12 clusters; each cluster had students with varied academic capabilities, and students were anonymous.

The lecturer was available between 8 am and 10 pm. To promote peer-based interaction, reduce lecturer dominance and ensure students ownership of their learning, he was only actively involved when students were stuck. A researcher from another university followed the activity in WhatsApp, providing general guidance to students upon request. He observed interactions and interviewed 15 students about their experiences of using WhatsApp (how it affected their emotions, participation etc.). A questionnaire was used to investigate WhatsApp's physical, technical and functional affordances in relation to their pedagogical value.

108 6 were English language speakers, 14 Africaans, 15 Xhosa, 2 Chinese and 55 Sesotho.

Findings indicate increased student participation, the fostering of learning communities for knowledge creation and shifts in the lecturers' instruction. Problems encountered were resentment of the merging of academic and family life occasioned by WhatsApp consultation after hours and ambivalence among students on the wide-scale-roll-out in different academic programs.

Zheng at al. (2015) argue that wikis as a CSCL environment cannot facilitate classroom collaboration without an effective learning design. The authors therefore developed strategies for designing wiki-supported curriculum. The paper outlines theories and prior research upon which the design was based, the implementation of the iterative design-based project, and the teaching and learning strategies developed in the study. Researchers reported that collaborative writing on wikis promotes the co-creation of knowledge and can, in theory, support the development of learning communities.

The research was conducted over four semesters in 2007 and 2009, in a Web 2.0 Tools and Social Learning course at a university in northern China. It followed an iterative cycle: a wiki-based learning activity was designed; the design was implemented and data collected using a variety of methods; the design was then evaluated and analysed for problems. Following this, an attempt to address these problems was implemented in the redesign, which then followed the same cycle through four iterations. Participants were postsecondary students.

Data included participant observation, surveys, interviews and participant-produced documents. At the end of the fourth activity, a survey was administrated that queried students' participation in and perceptions of the wiki-based collaborative activity. Survey responses were analysed using descriptive statistics. Interviews with 4-5 participants were conducted in all activities, to ask about students' general opinions of activities and challenges encountered during the activities. Documents – including student and teacher wiki work and participation on social media – were also collected.

During the process of detecting problems and refining the design, three instructional strategies emerged: Developing a learning community; Forming groups; Role assignment.

At the beginning, most students were excited and motivated about this project. Only 21% felt obligated to participate because it was a class assignment and only 7% did not want to participate. Students' motivation mainly came from their own interest, followed by incentives from instructor or peers. 100% of the survey respondents agreed that wiki is a favourable tool to support collaborative learning. Strategies developed in this study may enable teachers conducting similar collaborative activities to avoid problems related to instructional designs. Future research should not only address the development of teaching strategies, which may be context- and platform specific, but also iterative design approaches for refining these strategies.

3.4 Collaborative learning has shown that when students work in groups, responsibility is frequently dispersed. This highlights the need for learning designs that support collaboration and activate each student. Students in higher education are expected to learn to argue. In academically productive talk (APT), students learn scientific reasoning through building on prior knowledge and logically connect their contributions to domain concepts to support their claims and arguments. Encouraging students to make their knowledge sources explicit is considered vital in academic settings. Studies also find that student collaboration happens more spontaneously in apps designed for social media use than in more formal learning technologies. Research on telecollaboration reveals traditional teaching practices with email dominating the communication. Depending on the design, Wikis are perceived as a favourable tool to support collaborative learning. Researchers also ask why academics don't recognize their own responsibility for professional development in technology use in teaching, but expect external initiatives.

3.5 BARRIERS TO TECHNOLOGY USE AND INNOVATIVE TEACHING

Five studies find barriers to technology use in higher education institutions that may explain why teaching in higher education institutions remain teacher-centred, while the intention is a student-active learning approach. Despite much talk about the potential of technology to transform teaching and learning in higher education, much university teaching remains fundamentally unchanged.

A tension between external and internal is detected, explaining concerns raised by staff. The introduction of technology is often described as top-down, externally driven. If technology use is enforced by the faculty, teachers can lose their sense of personal agency; some even fear that if students can learn online, they will stop attending the lectures. At the same time, research finds inertia in the institutions. Implementation progress is slow and *sharing* of innovative practices appears not to be happening. Educational technology is more about technology, less about pedagogy and learning design, and there is a gap between the institutional rhetoric of TEL and the reality.

AUTHOR	COUNTRY	HAVE INVESTIGATED	METHODS USED
Amemado (2014)	Canada	Integrating technologies in higher education	Semi-structured interviews
Kirkwood & Price (2013)	UK	Technology enhanced learning	Essay
Shelton (2017)	UK	Why university lecturers stop using technology in teaching	Qualitative (Interviews)
Sinclair & Aho (2018)	UK	Super innovators – understanding the use of LSM	Qualitative (Interviews)
Walker, Jenkins & Voce (2017)	UK	Technology enhanced learning	Quantitative (longitudinal survey data)

Amemado (2014) interviewed 24 technology specialists and teaching centre experts in academic institutions, to identify how online technologies can enable effective collaboration in university learning environments. All informants were experienced technology users, specialists in university teaching and/or directors of teaching and learning centres. The study finds that technology innovation was mostly triggered by external reasons, such as "fad, cure-all illusion, pressure from students or competition from the online education market etc." (p. 21). Only 25 % of the informants mentioned internal reasons, such as collaborative work or distance education. Tools mentioned in the interviews were LMS, wireless, Web 2.0 technologies and video, mobile devices. The author notices that these technologies are not the newest, and infer that this might indicate a digital *gap* between higher education institutions and the rest of the society.

Kirkwood & Price (2013) argued that university teachers perceive *teaching* differently. Some have *teaching-focused* conceptions, others have *learning-focused* conceptions. Variations in conceptions of teaching can account for how technologies or tools are used. Teaching-focused individuals are more likely to use technology to support existing transmissive teaching strategies, while learning-focused individuals are more likely to use technologies that facilitate and support students' learning and development.

In a previous literature review[109], the authors have tried to identify a *scholarly* approach in the research on technology use in education, asking:

- What evidence was being used to drive the innovation/intervention?
- What evidence was gathered?
- What evidence illustrates changes in the professional practice of teachers in higher education?

Few of the reviewed articles exhibited a *scholarly* approach to teaching, both in how technologies are implemented and how researchers report from interventions. Much TEL research concentrates on technology as the *object* of attention and as the *agent* of change – rather than teaching and/or learning. According to the authors, transmissive teaching beliefs permeate the sector. Even the most innovative teacher can be constrained by institutional contexts or discouraged by professional development programmes that focus primarily on 'how to' approaches instead of activities that help them reconsider deeply held beliefs about teaching. Too often, teachers seem to be asking 'What can I use this technology or tool for?' rather than 'How can I enable

109 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.

my students to achieve the desired learning outcomes?' or 'What forms of participation or practice support learning?'. Professional development of academics in technology use should primarily be about their approaches to teaching.

Shelton (2017) explored how university lecturers used technology, and why they stopped using it. Interviews were conducted with eleven experienced university educators from various faculties. Findings indicate that teachers don't always see the replacement of old technologies with new as an improvement because they must learn new skills and unlearn old. If a new technology is not aligned with the teachers' pedagogical practice, it is less likely to be used by the teachers. Another reason to stop using technology is bad experiences. Having experienced many technical failures, or too little student engagement, teachers might revert to traditional teaching methods. The study found the following reasons why lecturers stopped using a technology: the emergence of a *new* technology; when students consider certain technologies as *outdated*; lack of *professional development*; and lack of *technical support*. Social media may be discarded by some teachers, because it blurs the line between their professional and personal life. When technology is integral to the course design, it is harder for teachers to stop using it.

Sinclair & Aho (2018) conducted a qualitative study in one Finnish university (5000 students, 200 teaching staff) and one British university (25.000 students and 2500 teaching staff), on the use of Learning Management Systems (LMS). An LMS is an integrated platform used to present resources, facilitate administration and communication, and support learning activities[110]. The study aimed to better understand the relationship between LMS use and teachers' expressed beliefs and attitudes, and how institutions can support more innovative adoption and development of pedagogy.

Studies found that most staff use LMS' only for very basic functions. An often-mentioned benefit among instructors (39 %) was better communication to students, while only 7 % thought it improved teaching and learning[111]. There was little indication that pedagogy developed significantly even after years of institutional adoption.

Two LMS expert (Moodle) administrators, one from each university, were interviewed about their perspectives on the attitudes of teaching staff that they support. While there is a strong belief in the motivational effect of enthusiastic colleagues, the informants in this study find that sharing is not happening. Most teachers were observed to start with the basic functions and never progress: '*Most of them who use it think that they can utilise it well. But they can't'* (p. 167). Both informants noted that staff often stated pedagogic, student-focused reasons for using the LMS, while in practice an estimated 50 % of teaching staff (after three years) and 15-20 % (after 10 years) were not using the system at all, even for purely informational purposes. One says: *'They only put their material in Moodle and then they think ok, that's it. I can stop here'* (p. 166).

Interviews were analysed in two themes, first, *what* teachers do and second, *why* they do it? Teacher behaviour may be grouped in four categories: 1) Initiators, 2) Followers, 3) The reluctant or unwilling and 4) Non-users: '*We still have people who aren't using Moodle even though we have had it for 10 years'* (p. 165). Pedagogic initiators and innovators were described as willing to explore, open to experiment and risk-accepting; characteristics seen as lacking in most users. Barriers noted were described as intrinsic, deep-rooted, individual, subjective and difficult to address: *'It's an ideological thing'* (p. 169).

The experts viewed pedagogical and conceptual issues as fundamental inhibitors of progress, and did not ascribe them to age, but to personality: '*they are scared of technology, and that's their threshold'* (p. 167). Some teachers connect their reluctance to technology use to personal weakness and failure, even something shameful. Being a teacher implies to *know* and be on top of things. Not fully mastering

110 Costello, E. (2013). Opening up to open source: Looking at how Moodle was adopted in higher education. Open Learning: *The Journal of Open, Distance and e-Learning, 28*(3), 187-200.

111 Lonn, S., & Teasly, S. D. (2009). Saving time or innovating practice. Investigating perceptions and uses of learning management systems. *Computers & Education, 53*(3), 686-694.

technology threatens their authority. For some, fear of technology becomes fear of perceived failure and a threat to professional standing. Other teachers feared that students would stop attending the lectures – *'they don't have to turn up to see the performance of a lecture because they have access to all the information in other ways'* (p. 168). A third group of teachers argue that they *'need to have the students in a room to show something in a way that technology is nowhere near close to doing'* (p. 169). These teachers see their teaching practice as sacred: '*lectures are seen somehow as the sacred thing that must continue and everything else must to some extent bend around it'* (p. 170).

Current institutional support for staff is often based on training courses, online resources and individual support: '*We have just noticed that the training sessions that we have organised, it's not a good idea. Nobody comes and nobody learns anything'* (p. 170). Researchers reported that better understanding of the reasons behind the lack of progression and an approach to staff development which helps teachers to understand and confront their conceptual barriers is needed. The state of inertia in technology use identified in the study is partly related to conceptions of teaching and what it means to be a teacher. These issues must be understood to meet the concerns of teaching staff.

Walker, Jenkins and Voce (2017) report on the developments of Technology Enhanced Learning (TEL) in higher education institutions in the UK. The study draws on longitudinal survey data and case studies from UCISA[112] on TEL implementation, from 2012, 2014 and 2016, in addition to qualitative interviews with institutions about their approaches to TEL developments. Although institutional investment in TEL has been significant, there is no substantial change in how the technologies are used. A gap is revealed between the institutional rhetoric of TEL and the reality of its impact on academic practice. A barrier identified in the 2016 UCISA survey was departmental culture, related to many factors; lack of time and support, healthy scepticism concerning the value of digital provision in supporting student learning, and resistance to top-down strategies from institutional management, which may lead to a lack of commitment to change academic practices.

Instructional support for online learning requires strategies to facilitate effective group learning and participant-led activities. To develop these skills, academics need professional development, addressing both technology and pedagogic practice. Researchers reported that the introduction of TEL tools in UK HE institutions has focused on institutional responsiveness to student expectations and needs by investments in centrally managed systems. However, far less attention has been paid to addressing academic staff needs in the process.

3.5 Barriers to technology use and innovative teaching has shown significant barriers to technology use in higher education institutions. One interesting finding is that academics appear to not be using a *scholarly approach* when implementing technology in education. A finding cutting through all five studies is institutional inertia and a reluctance among lecturers to change practice. Researchers argue that this reluctance must be addressed and understood, and stress that the focus of staff development programs in higher education must be on instructors' perception of teaching and learning, as technology appears not the main barrier. While staff obviously must know how technology works, and be familiarised with the potential in technology, research indicates that pedagogy is a more fundamental barrier to innovative teaching in higher education than technology. To be perceived as relevant for younger generations, institutions need heightened awareness of a potentially emerging technological gap between the institutions and the rest of society.

112 The Universities and Colleges Information Systems Association (UCISA)

4 PREREQUISITES FOR STUDENT ACTIVE LEARNING IN HIGHER EDUCATION

Chapter four brings together and synthesises findings from the 35 included articles.

The systematic review was conducted to answer how teaching with technology can support student active learning in higher education. The first chapter, *Introduction,* showed policy expectations. White Paper no. 16 (2016-2017) *Culture for Quality in Higher Education*[113], the long-term plan for research and higher education[114], the report from the EU commission[115], and the strategy for digitalisation of higher education[116] all stress that technology should be used innovatively, to support student active learning and develop new teaching strategies. Chapter 3 first presented studies on learning analytics and learning design. While big data bring new possibilities, it also requires that institutions develop *data literacy* as staff face the challenge to use abstract information (numbers and percentages) pedagogically, when developing learning designs. MOOCs were introduced with ambitious visions, but studies see few traces of their prospected transforming potential. Research on capture technology suggests that staff should focus on the *why* of technology use, not on the *how*. Studies on mobile learning find a persistent behaviourist learning paradigm in the institutions, and conclude that mobile learning need new and extended learning designs. Augmented Reality and emerging technologies show promise, but are still at the early stages. Based on the reviewed studies, it is reason to suspect that also new technologies can risk being adapted to traditional teaching. Throughout chapter 3, the included studies show a consistent pattern: while researchers *assume* the transforming potential of technology, studies find few examples of sustainable innovative teaching practices, few examples of successful student active learning designs and findings on student motivation and learning outcomes are inconsistent and inconclusive.

Studies on barriers to technology use find *inertia* in institutions. They conclude that *sharing* of exemplary practices is not happening; staff shows *reluctance* to change; a behaviouristic *mindset* persists and *prescriptive* practices dominate. The overall picture is that traditional ideas about how students learn dominate. As technology is mainly used administratively and for one-way communication, the interactive potential in technology is underutilised and technological devices are *adapted* to familiar work processes.

To narrow in on the question how teaching with technology can support student active learning, the included studies were uploaded in NVivo 11, analysed, and coded according to the main patterns identified across the studies. As chapter 3 shows, most studies emphasised the need to change teaching *from content delivery to student active learning* and most studies stressed the need for *staff professional development*.

First pattern: From content delivery to student active learning

Analysis shows that 25 of the 35 included studies mention student active or student-centred learning. The arguments revolve around instructional approaches or learning designs that require students to actively collaborate in groups or on discussion

113 Meld. St. 16 (2016–2017). *Kultur for kvalitet i høyere utdanning* https://www.regjeringen.no/no/dokumenter/meld.-st.-16-20162017/id2536007/

114 Meld. St. 7 (2014-2015). *Long -term plan for research and higher education* 2015-2024

115 European Commission (2014). *Report to the EU Commission on New modes of learning and teaching in higher education* http://ec.europa.eu/dgs/education_culture/repository/education/library/reports/modernisation-universities_en.pdf

116 https://www.regjeringen.no/no/dokumenter/digitaliseringsstrategi-for-universitets--og-hoyskolesektoren---/id2571085/

forums. Collaborative learning is often used to exemplify active learning approaches, and technology is referred to as a tool that can support student active learning and the co-construction of knowledge. A majority of the 25 studies mention technology, but primarily as a tool with the purpose to administer content, as a means for content delivery in MOOCs (Toven-Lindsey et al., 2015), or to facilitate online collaboration by providing discussion forums, wikis, possibilities to share documents and so forth (Blau & Shamir-Inbal, 2017).

Six studies discuss collaboration between students (Blau & Shamir-Inbal, 2017; Cochrane 2014; Lee et al., 2018; Rambe & Bere, 2013; Tegos et al., 2016; Toven-Lindsey et al., 2015). Collaborative learning means that students are engaged in discussions, share what they have learned and provide feedback (Lee et al., 2018), work inquiry-based when solving problems and constructing knowledge (Blau & Shamir-Inbal, 2017; Toven-Lindsey et al., 2017). When they collaborate on solving tasks, students need a variety of social skills such as mutual respect, listening to others, understanding, cooperating, and avoiding conflict situations (Blau & Shamir-Inbal, 2017). Three studies mention collaboration between students and teachers, but without elaborating (Amemado, 2014; Barak, 2017; Blau & Shamir-Inbal, 2017). Collaboration amongst teachers is only briefly mentioned in two studies (Amemado, 2014; Cochrane, 2014); without examples or further elaboration.

Student active learning is used about instructional approaches that actively engage students in the learning process through collaboration and discussions rather than having them passively receive information from their instructors (Lee, Morrone & Sierring, 2018). It is argued that for active learning to succeed, educators must create new and extended learning designs that link different pedagogical strategies. When teaching with technology, learning designs also span different contexts. Studies question if current staff training courses develop these skills and competences, and call for new approaches to professional development in higher education institutions.

One solution, frequently mentioned in the studies, is that teachers abandon a behaviouristic perspective on learning and instead adopt a socio-cultural, constructivist approach. If this happens, technology will, supposedly, facilitate the move from teaching as content delivery to student-active learning. This might be easier said than done. A review of learning research[117] found that behaviourism, cognitive and socio-cultural learning theories have developed historically, but not as major paradigmatic changes. Studies that built on behaviourism defined learning as changed behaviour; studies that built on cognitivism defined learning as internalisation of external knowledge and studies taking a sociocultural perspective defined learning as situated, social and active processes where people learn through participating in cultural and social practices. Researchers who draw on behaviourist and cognitive perspectives are primarily interested in individual learning, while researchers with an interest in collaborative learning activities find support in social and cultural learning theories. A characteristic of the educational ecosystem is, however, that these three perspectives on learning live side by side and serve different purposes. When studies suggest to abandon the behaviouristic perspective, this is therefore only, at best, part of the solution. Teachers take several consideration when planning their teaching. They prefer methods they perceive as *useful* for the purpose, *easy* to use, that can be *adapted* to the students' needs and *fits* the physical surroundings.

Second pattern: Staff professional development
Studies find that pedagogical use of technology in teaching is challenging. Technical training in how to use technology is necessary, but not sufficient, when the goal is innovative teaching and more student active learning. Researchers argue that pedagogical considerations must be integrated in all efforts to motivate teachers to use technology. 19 studies mention different training needs, spanning learning about the potential of technology and technical details; pedagogical training i.e., learn new teaching methods and data literacy i.e., learn how to use data productively to achieve meaningful results (Avella et al., 2016), but also more general professional development activities.

As technology often is initiated from the top, not based on teachers' needs, technology enhanced learning is frequently also technology driven. Several

117 Murphy, P. K., & Knight, S. L. (2016). Exploring a Century of Advancements in the Science of Learning. *Review of Research in Education*, *40*(1), 402-456.

studies highlight the need for a *pedagogical framework* that take teachers' conception of learning and why teachers chose to teach as they do into consideration. Researchers argue that questions related to pedagogy must guide the use of technology in teaching, and not vice versa (Barak, 2017; Cochrane, 2014; Kirkwood & Price, 2013; Newland & Byles, 2014; Walker et al., 2017), and several studies conclude that professional development programmes with the aim to promote technology use in teaching should motivate teachers to reflect on their beliefs about teaching.

Key to answering the question how teaching with technology may support student active learning appears to be how staff professional development courses are designed and conducted. The traditional model of taking lecturers out of their everyday work situation to inform them about the potentials of new technology and alternative teaching approaches appears unproductive. Based on the analysed articles, two main topics must be central in higher education professional development for teaching with technology to support student active learning: *learning design* and *collaborative learning*.

This finding has implications for how institutions fund, plan and structure professional development.

Learning design goes beyond traditional planning for a lesson, and requires joint effort by a group of teachers. Collaborative learning is central to learning design, and teachers are currently expected to teach students how to collaborate, while most teachers work individually.

A scholarly approach to teaching

Challenges related to teaching are more often shared across than within academic disciplines. For example, will themes such as teaching with technology or student active learning transcend disciplinary boundaries. However, opportunities for staff to collaborate and learn from one another are limited because there are few mechanisms in place to support academics' teaching and few incitements to support teacher collaboration. In a systematic review on campus development[118], it was noted that while higher education institutions have a well-developed infrastructure to support research, a similar infrastructure appears to be lacking for teaching. Paradoxically, work methods differ when academics conduct research and when they teach. When researching, academics use inquiry-based, investigative approaches, work collaboratively co-author and disseminate findings. Increasingly, research is perceived as a collective responsibility, but teaching remains, predominantly, an individual responsibility. While research is perceived as a knowledge intensive, cumulative knowledge-building endeavour with a joint knowledge base, guidelines, methods and ethical boards, teaching in higher education has not yet gained similar status.

As shown in 3.5, *Barriers to technology use and innovative teaching*, Kirkwood and Price (2013) argue for a scholarly approach to teaching:

"The scholarship of teaching and learning is, at its core, an approach to teaching that is *informed by inquiry and evidence* (both one's own, and that of others) about student learning. It is not so much a function of what pedagogies [teachers] use. Rather, it concerns the thoughtfulness with which they construct the learning environments they offer students, the attention they pay to students and their learning, and the engagement they seek with colleagues on all things pertaining to education in their disciplines, programs, and institutions" (Kirkwood & Price 2013, p. 329[119])

Without using the term scholarly, a majority (22) of the included studies argue for similar perspectives on teaching, when they refer to inquiry-based and iterative learning designs, student active learning and collaboration. Other studies highlight scientific reasoning as an approach to student active learning in higher education (Tegos et al. 2016) or ontological shifts, emerging from sustained interactions (Cochrane, 2014).

118 Lillejord, S., Børte, K., Nesje, K., & Ruud, E. (2017). Campusutforming for undervisning, samarbeid, forskning og læring – en systematisk kunnskapsoversikt. Oslo: Kunnskapssenter for utdanning. www.kunnskapssenter.no

119 Citing Hutchins, P., M. T. Huber, & Ciccone, A. (2011). Getting There: An Integrative Vision of the Scholarship of Teaching and Learning, *International Journal for the Scholarship of Teaching & Learning* 5 (1).

Many academics lack fundamental professional development and are not encouraged to keep up to date with teaching research. Professional development provision tends to be under-resourced and disconnected from discipline activities[120]. Newly appointed academics may find their first teaching experience stressful, and report feeling thrown in at the deep end with little support[121]. On this background, researchers suggest that academic work should be regarded as a *professional practice*[122]. Institutions expect staff to teach to a certain standard, and should provide training, with the ambition to develop *scholarly teachers*[123], who are research-informed, inquire into their teaching practice, and disseminate what they find. Scholarly teachers take advantage of institutional programs and initiate their own professional learning. One study (Cochrane, 2014), suggests *Professional Learning Communities* (PLCs) as sites where staff can collaborate to develop their teaching practice[124]. PLCs have supportive leadership and an action- and results-oriented focus on collaboration and experimentation to support teaching and learning, and aims to de-privatise teaching[125].

This is not a new idea. Structured, multidisciplinary *Faculty Learning Communities* (FLCs)[126], were developed at Miami University in 1979, with the goal to develop a scholarly product, usually Scholarship of Teaching and Learning (SoTL)[127], professional development that promotes research-informed teaching. Others, and similar, initiatives build on the observation that academics do not generally engage with systematic peer-review of teaching[128] with constructive feedback [129]. To be sustainable, procedures for institutionalised, continuous professional development, require procedures for knowledge accumulation and sharing, leadership and processes for renewal. As the authority of professional expertise is more respected in academic institutions than traditional forms of positional power[130], the status of teaching must be heightened and an infrastructure developed to support continuous inquiry into questions of pedagogy and didactics.

Findings from studies in this systematic review has implications for how institutions plan and conduct programs for academic development[131]. Provision-driven staff development builds on a deficit-model, which assumes that someone is lacking something, for instance knowledge or skills. Programs that aim at motivating academics to teach with technology in a way that promotes student active learning must build on the assumption that academics have the necessary competences, but that they need leader support and supporting structures.

120 Boud, D., & Brew, A. (2013). Reconceptualising academic work as professional practice: Implications for academic development. *International Journal for Academic Development*, *18*(3), 208-221.
Roxå, T., & Mårtensson, K. (2009). Significant conversations and significant networks–exploring the backstage of the teaching arena. *Studies in Higher Education*, *34*(5), 547-559.

121 Fraser, K., Greenfield, R., & Pancini, G. (2017). Conceptualising institutional support for early, mid, and later career teachers. *International Journal for Academic Development*, *22*(2), 157-169.

122 Boud, D., & Brew, A. (2013). Reconceptualising academic work as professional practice: Implications for academic development. *International Journal for Academic Development*, *18*(3), 208-221.

123 Myatt, P., Gannaway, D., Chia, I., Fraser, K., & McDonald, J. (2018). Reflecting on institutional support for SoTL engagement: developing a conceptual framework. *International Journal for Academic Development*, *23*(2), 147-160.

124 Cherrington, S., Macaskill, A., Salmon, R., Boniface, S., Shep, S., & Flutey, J. (2017). Developing a pan-university professional learning community. *International Journal for Academic Development*, 1-14.

125 DuFour, R., & Eaker, R. (1998). *Professional Learning Communities at Work: Best Practices for Enhancing Students Achievement*. Bloomington IN: National Educational Service.
Hipp, K. K., & Huffman, J. B. (Eds.) (2010). *Demystifying professional learning communities: School leadership at its best*. Lanham, MD: Rowman & Littlefield Education.

126 Cox, M. D. (2013). The impact of communities of practice in support of early-career academics. *International Journal for Academic Development, 18*(1), 18-30

127 Fanghanel, J., Pritchard, J., Potter, J., & Wisker, G. (2016). *Defining and supporting the scholarship of teaching and learning (SoTL): A sector-wide study.* York: HE Academy.

128 Barnard, A., Nash, R., McEvoy, K., Shannon, S., Waters, C., Rochester, S., & Bolt, S. (2015). LeaD-In: a cultural change model for peer review of teaching in higher education. *Higher Education Research & Development*, *34*(1), 30-44.

129 Kolb, D. (1984). *Experiential learning as the science of learning and development*. Englewood Cliffs, NJ: Prentice Hall.

130 Bento, F. (2011). A discussion about power relations and the concept of distributed leadership in higher education institutions. *The Open Education Journal 4*, 17-23.

131 Boud, D., & Brew, A. (2013). Reconceptualising academic work as professional practice: Implications for academic development. *International Journal for Academic Development*, *18*(3), 208-221.

5 CONCLUSION AND KNOWLEDGE GAPS

Law for universities and colleges § 1-3, state that teaching in Norwegian higher education institutions must be based on R&D, research- and experience based development[132]. In a previous review[133], the Norwegian Knowledge Centre concluded that modern universities, expected to develop new teaching methods, need an infrastructure for *teaching* in addition to the already established infrastructure for research. One consequence of perceiving academic work as a professional practice, is that universities and colleges must establish higher education teaching as a knowledge field with a knowledge base, equipment, tools and collective work processes. This work needs a supporting infrastructure and leadership.

In chapter four, it was argued that a *scholarly approach* to teaching is a prerequisite to develop student active learning. There is no reason why teaching should not be an inquiry-based activity. It should, however, be acknowledged that individual teachers who work in lecturing halls designed for rational one-way transmission of content from one teacher to many students find it difficult to change practices deeply ingrained in structure, history and culture. Teachers prefer methods they find easy to use, that fit the physical surroundings, are useful for the purpose, and can be adapted to their students' needs.

An institution-wide scholarly approach to teaching is suggested as a mean to obtain student active learning. The analysed studies show that plans and strategies communicate high expectations, while responsibility for the follow-up appears to be somewhat dispersed in the sector. The systematic review therefore concludes that teaching with technology can promote student active learning only through a joint, coherent, multi-level effort.

In the introduction, it was referred to the digitalisation strategy (2017-2021)[134], developed by the Norwegian Ministry of Education and Research. The strategy argues that the conscious use and development of technology must be an integral part of national and institutional strategies. This supports the argument for a multilevel effort, and Figure three shows responsibilities at national and institutional levels.

A core message in this systematic review is that technology implementation in higher education intuitions must follow a scholarly approach; be aligned with goals for teaching and research stated in national and institutional plans and strategies, what students expect to learn in higher education, tested in a variety of formats, evaluated and renewed in accordance with acknowledged and familiar academic work procedures, big data, student feedback, teacher feedback and new research. This work needs leadership and can only be achieved through a collaborative effort.

132 https://lovdata.no/dokument/NL/lov/2005-04-01-15

133 Lillejord, S., Børte, K. Nesje, K. & Ruud, E. (2017). *Campusutforming for undervisning, forskning, samarbeid* og *læring – en systematisk kunnskapsoversikt*. www.kunnskapssenter.no

134 https://www.regjeringen.no/no/dokumenter/digitaliseringsstrategi-for-universitets--og-hoyskolesektoren---/id2571085/

Who are responsible for what?

NATIONAL LEVEL
National Policy, Priorities & Strategies

INSTITUTIONAL LEVEL

Leadership responsibilities	Staff responsibilities
Infrastructure for teaching: • Institutional ICT policy initiative • Funding • Training to develop scholarly teachers - learning design - collaborative learning • Establish a knowledge base for teaching • Develop ethical guidelines and methods • Attention to ethical issues	**Develop a «scholarly» approach to teaching:** • Research and experience informed teaching • Inquire into own teaching practice • Disseminate findings • Take advantage of institutional programs • Initiate own professional learning • Maintain and renew the knowledge base

Figure 3. Responsibilities at national and institutional levels.

KNOWLEDGE GAPS

The systematic review has identified these knowledge gaps:

- There is a need for longitudinal studies to investigate how technology is adopted over longer periods of time, not only early adoption.
- For the progressive knowledge development within this research field, there needs to be a change from the current focus on simply exploring the latest technology in quasi- experimental evaluations.
- Characteristics of beneficial student active learning should be empirically investigated.
- There is a need for more consistent and rigorous study designs (common methods, consistent concept use, measures and reporting standards) and objects of study
- Studies should establish characteristics of effective knowledge scaffolding, social factors, feedback, timing, assessment modalities etc.) to help understand what attributes of a learning environment leads to improved learning outcomes.
- Empirical research on teaching strategies and learning outcomes associated with MOOCs is limited.
- There is limited evidence in the literature that the flipped classroom and personalised learning leads to better grades and improved learning outcomes.
- Currently lacking in the literature is research about what level of control is beneficial for students, and at which level of flexibility higher education courses are effective in improving student engagement, experience and learning outcomes.
- Future research should not only address the development of teaching strategies, which may be context- and platform specific, but also iterative design approaches for refining these strategies.
- More systematic reviews are needed to establish the knowledge status of various topics and research strands.

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APPENDIX 1 SEARCH STRING

Search string (Scopus syntax)

TITLE-ABS-KEY("1 to 1 computer" OR "blended learning" OR "CAI" OR "CAL" OR "CBL" OR "cloud computing" OR "collaborative learning" OR "computer aided" OR "computer assisted instruction" OR "computer assisted learning" OR "computer based instruction" OR "computer based learning" OR "computer based teaching" OR "computer simulation*" OR "computer supported" OR "computer technology" OR "computer use" OR "computer-aided" OR "computer-assisted instruction" OR "computer-assisted learning" OR "computer-based instruction" OR "computer-based learning" OR "computer-based teaching" OR "computerized instruction" OR "computers and learning" OR "computers in education" OR "computer-supported" OR "computing education" OR "digital learning" OR "digital technology" OR "educational technology" OR "e-learning" OR "electronic learning" OR "game*" OR "ICT*" OR "information communication technolog*" OR "innovative technology" OR "Instructional technologies" OR "intelligent tutoring system*" OR "interactive learning environment*" OR "interactive learning object*" OR "interactive simulation*" OR "Interactive white board*" OR "learning effect*" OR "local area network*" OR "massive open online courses" OR "media in education" OR "mobile learning" OR "MOOC" OR "multimedia learning" OR "OER" OR "one to one computer" OR "one2one computer" OR "online learning" OR "online learning communities" OR "online open educational resources" OR "online self study" OR "online study" OR "rich media" OR "serious game*" OR "simulation based education" OR "simulation based teaching" OR "simulation-based education" OR "simulation-based teaching" OR "simulations" OR "social network" OR "supplemental CAI" OR "tablet*" OR "technology enhanced instruction" OR "technology enhanced learning" OR "technology use" OR "technology-enhanced instruction" OR "technology-enhanced learning" OR "TEL" OR "tutoring system*" OR "virtual learning" OR "virtual reality" OR "VLE" OR "web-based instruction*" OR "web-based learning" OR "web-based training" OR "wireless network*") AND TITLE-ABS-KEY("active learning" OR ("collaborat*" W/5 "lecturer") OR ("collaborat*" W/5 "student") OR ("collaborat*" W/5 "teacher") OR "effective learning" OR "enhanc* learning" OR ("innovative" W/5 "learning") OR ("innovative" W/5 "teaching") OR ("interact*" W/5 "lecturer") OR ("interact*" W/5 "student") OR ("interact*" W/5 "teacher") OR "learning delivery" OR "learning design" OR ("learning" W/5 "flexible") OR ("learning" W/5 "personali?ed") OR "pedagog*" OR "teaching delivery" OR "teaching method*" OR "teaching model*") AND TITLE-ABS-KEY("college" OR "faculty" OR "HE" OR "higher education" OR "university")

APPENDIX 2 MAPPING OF METHOD AND QUALITY

REFERENCE	METHOD	QUALITY
Akiyama & Cunningham (2018)	Literature review	Medium
Al Nashash & Gunn (2013)	Quantitative and qualitative	Medium
Ali et al. (2017)	Theoretical	Medium
Amemado (2014)	Qualitative	Medium
Avella et al. (2016)	Systematic review	High
Barak (2017)	Mixed methods	High
Blanco-Fernández et al. (2014)	Qualitative	Medium
Blau & Shamir-Inbal (2017)	Qualitative	High
Cochrane (2014)	Qualitative	Medium
Dennen & Hao (2014)	Qualitative	Medium
Edmonds & Smith (2017)	Quantitative and qualitative	High
Hung et al. (2018)	Quantitative	Medium
Jones & Bennett (2017)	Theoretical	High
Kirkwood & Price (2013)	Literature review	Medium
Lameras et al. (2017)	Literature review	High
Lee et al. (2017)	Mixed methods	Medium
Maringe & Sing (2014)	Literature review	High
Mesh (2016)	Quantitative	Medium
Newland & Byles (2014)	Qualitative	High
Ng'ambi (2013)	Quantitative and qualitative	High
Pimmer et al. (2016)	Systematic review	High
Rambe & Bere (2013)	Quantitative and qualitative	Medium
Rienties & Toetenel (2016)	Quantitative	High
Shelton (2017)	Qualitative	High
Sinclair & Aho (2018)	Qualitative	Medium
Tegos et al. (2016)	Quantitative	High

REFERENCE	METHOD	QUALITY
Toven-Lindsey et al. (2015)	Qualitative	High
Van Es et al. (2016)	Quantitative and qualitative	High
Vlachopoulos & Maki (2017)	Systematic review	High
Walker et al. (2017)	Qualitative	High
Wang (2017a)	Quantitative and qualitative	High
Wang (2017b)	Quantitative and qualitative	High
Wanner & Palmer (2015)	Quantitative and qualitative	High
Witton (2017)	Quantitative and qualitative	Medium
Zheng et al. (2015)	Quantitative and qualitative	Medium

PREVIOUS PUBLICATIONS FROM THE KNOWLEDGE CENTRE FOR EDUCATION

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