TECHNOLOGY FOR LIFELONG LEARNING

Teknologirådet

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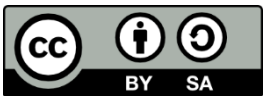


FOREWORD

New technology is changing jobs and our need for skills in society. An important point on the political agenda is how we can develop our skills throughout our lifetime in order to adapt to the changing job market.

This report from the Norwegian Board of Technology argues that technology will be an important part of the solution required to achieve this. The same technology that is posing a threat to jobs is also creating new opportunities for learning. We see potential in the technology, as well as some challenges.

This report is part of the Norwegian Board of Technology's project on lifelong learning and new jobs. We will go into further detail on what a flexible system for lifelong learning might look like in the project's next report.

The expert group for the project consists of the following members:

- Marit Aursand, Head of Research for Process Technology at SINTEF Ocean and a member of the Norwegian Board of Technology
- June M. Breivik, Department Head for Arts, Culture and Schools at Kulturtanken
- Karsten Bråthen, Chief Researcher at the Norwegian Defence Research Establishment
- Reidun Høllesli, Senior Vice President of Orkla IT and a member of the Norwegian Board of Technology
- Trond Ingebretsen, Director of Digitalisation at the Norwegian Directorate for Education and Training
- Johan Røed Steen, Researcher at Fafo
- Elisabeth Ramstad, Head of Personnel at the Norwegian Government Agency for Financial Management

The Norwegian Board of Technology's Project Managers Marianne Barland, Silje Morsman and Renira Angeles are responsible for leading the project.

The Norwegian Board of Technology provides independent advice to the Norwegian Parliament (Stortinget) and government about new technology and stimulates public debate on the issue. We hope that this report will contribute to an ambitious discussion about the potential offered and challenges posed by new technology in lifelong learning.

Tore Tennøe

Director, the Norwegian Board of Technology

CONTENTS

INTRODUCTION

New technology is changing the face of jobs as we know them, triggering new skills requirements. How can the same technology that is posing a challenge to jobs also be used to strengthen the potential for lifelong learning?

TECHNOLOGY IS CHANGING JOBS

Digitalisation, automation and artificial intelligence are changing our jobs as we know them. In recent years, a number of studies have given different estimates to how many jobs can be automated, and what impact technology will have on the labour market as a whole.[1] On the other hand, there is broad consensus that jobs are facing a digital shift. In short, we can summarise as follows:

- Estimates for the share of jobs that can be wholly automated range from around 6 per cent[2] to 33 per cent[3] in the Norwegian context.

- Most jobs will see their tasks change, and many will be radically different in their scope.

[1] For example Frey and Osborne (2013), Pajarinen et al. (2014), Arntz et al. (2016), McKinsey Global Institute (2017) and Nedelkoska and Quintini (2018)
[2] Nedelkoska and Quintini (2018)
[3] Pajarinen et al. (2014)

- The impact of digitalisation is widespread and will also simultaneously have a major impact on skills requirements.

- Skills requirements will change more frequently in factories, offices, hospitals, on the roads and in retail once machines can do more.

A new study from the OECD indicates that up to 6 per cent of Norwegian jobs are at high risk of being wholly automated, and a further 26 per cent could see their scope changed radically.[4] If we assume that this 32 per cent of the workforce will need extensive skills-enhancing initiatives, this corresponds to 840,000 Norwegian employees.[5] This does not include jobs with a lower likelihood of being wholly automated, but which may also see their tasks changed and require different skills, and it omits those people not in work. By comparison, 217,000 Norwegians participated in further education resulting in formal, approved skills in 2017.[6]

SKILLS DEVELOPMENT IN NORWAY

Norway has a high employment rate and a generally high level of education amongst its citizens. The OECD's survey of adult skills also shows that there is a good basic level of skills amongst Norwegians when compared with other countries.[7] However, it has been observed in recent years that Norway is in the process of losing its advantage among countries that have invested significantly in education and lifelong learning.[8] Together with the challenges created by major changes to working life, this demonstrates the need for a new system for skills development in Norway. This is something that the government has also been clear about, especially by notifying its intentions to reform skills.[9]

[4] Nedelkoska and Quintini (2018)
[5] SSB (2018)
[6] Keute and Drahus (2017)
[7] OECD (2013)
[8] Norwegian Official Report (NOU) 2016:3 Chapter 1.3, p. 18
[9] The Norwegian Government (2018)

The Norwegian education system currently comprises a trajectory running from primary school and secondary education through to colleges and higher education. Further education is often used to top up formal skills later in life . At the same time, a lot of learning takes place outside the standard education system.

The technologies we describe in this report can be used at all these levels. However, our focus is on learning in adult life. Learning like this can take place in many different forms and in different arenas. These categories are defined and delimited differently, but it can generally be said that the following applies:[10]

- **Formal education** (further education) is education that leads to formal skills or study credits in the standard education system. This often involves learning something completely new.
- **Non-formal education** (continuing education) relates to courses, seminars and other organised learning that does not result in formal skills or study credits. This often involves the renewal or update of knowledge previously acquired.
- **Informal learning** refers to learning that occurs in daily work, for instance through new tasks or by learning from colleagues. Norway has a learning-intensive working life, and for the vast majority of working adults this is their most important learning arena.[11] Informal learning can also take place during leisure time, but distinguishes itself from random learning by the fact that it is planned - there must be a conscious desire for a learning outcome.[12]

TECHNOLOGY AND LEARNING – WHAT'S NEW?

In March 2018, the government established an expert committee to work with the skills reform; 'Learning Throughout Life'. The goal is that everyone should be qualified for a working life that is influx due to new technology. The committee will, amongst other things, evaluate which opportunities exist for learning throughout life, the need for continuing and further education, and whether the

[10] Tømte et al. (2015) and Norwegian Official Report (NOU) 2018:2
[11] Report to the St. 16 (2015-2016) Chapter 3, p. 29
[12] SSB (2017)

education system is in a position to meet the needs of working life in the future.[13]

The expert committee's mandate makes clear that new technology can make currently held skills outdated and trigger a need for continuous skills development. What is not highlighted is how the same technology that is changing the face of jobs can also change the terms of lifelong learning. It is completely necessary for the potential of new learning technology to be taken into consideration in a new system that will ensure lifelong and flexible learning for all.

Technological development has led to many predictions about learning revolutions over the years. In 1922, Thomas Edison stated that film would revolutionise the education system and make the use of school books obsolete.[14] Ten years later the book *Radio: The Assistant Teacher* was published, where Benjamin Darrow described how the radio would make knowledge available to everyone. Innovations such as film, radio, video, CD-ROM and computers have acted as supplements to established teaching practices, but these innovations have not realised the optimistic visions associated with them.

The rapid and widespread development we are seeing at present is a source of new optimism. The emergence of the Internet and spread of PCs, tablets and smartphones have led to a blossoming of new, digital forms of learning. These are often available to anyone, in unlimited quantities, at any time, and anywhere in the world. For example, YouTube has emerged as one of the world's biggest learning environments, featuring instructional videos on everything from programming to personal finance.

Online-based forms of teaching, such as Massive Open Online Courses (MOOCs), also make organised remote learning far more flexible and interactive than what was previously possible. At present, more than 80 million people have participated in at least one MOOC.[15] The range of Norwegian MOOCs remains limited, and a lack of incentives may partly explain this situation.[16] At the

[13] The Norwegian Government (2018)
[14] Pew Research Center (2016)
[15] Class Central (2018)
[16] Krokan (2017)

same time, Skills Norway's business barometer shows that less than half of Norwegian firms have access to learning that is flexible in terms of time and location.[17]

In recent years, artificial intelligence has made a number of breakthroughs. Large volumes of data and processing power combined with better algorithms make it possible to adapt learning to each individual. This is already coming into schools at full speed. At the same time, we are also seeing data-driven personalisation being used in other areas such as public services.[18]

The use of digital simulations is becoming increasingly widespread in teaching and learning contexts. One of the benefits is that it is possible to design worklike programmes of learning that enable people to practice specific tasks and situations that they are likely to encounter in their job. Technology for virtual, augmented and mixed reality, such as glasses and other equipment, are developing rapidly. This may change the terms of teaching and learning in the long term.

THREE OPPORTUNITIES FOR LIFELONG LEARNING

In this report, we outline how new technology can help to strengthen the potential for lifelong learning in three fundamental ways:

- **Remote.** The Internet and spread of PCs, tablets and smartphones have led to new digital forms of learning. This means that it's possible to participate in learning whenever and wherever, at a pace that suits you. MOOCs are a familiar example of this, and make it possible to move away from the traditional classroom environment.

  In contrast to radio and TV, it is also possible to construct a social dimension around the learning so that values from traditional teaching can be safeguarded and provided digitally. Social media, virtual colloquia and discussion forums are examples of remote learning that can now be made more interactive, rather than purely broadcasting knowledge.

[17] Holte (2017)
[18] The Norwegian Board of Technology (2017)

- **Personalised.** In digital learning situations, large volumes of data can be collected on an ongoing basis and analysed. This can contribute to understanding and improving the learning processes. Based on analyses of this kind, adaptive learning systems can adapt teaching in real-time to each individual participant's level and needs, and provide immediate feedback. Data analysis can also help to create the best possible basis for learning, adapted to participants' work and home commitments.

- **Simulated.** Digital simulations make it possible to design worklike and customised programmes of learning, connected closely to real work tasks and situations. This can encompass everything from 2D and 3D models on a PC or mobile to simulations that involve the use of virtual, augmented or mixed realities. The use of gamification can also increase the motivation to learn.

In summary, new learning technology makes it possible to continuously adapt teaching to each individual participant's needs. It is flexible and can be offered *when* there is a need for knowledge and *where* there is a need for it - for instance, in the workplace. Skills development can also become more affordable, since digital technology scales well and the need for absence from work for learning is reduced.

Technology also raises some important questions. Will increased flexibility and adaptation lead to more people participating in learning, or will it strengthen those who were previously best equipped? Personalisation and digital teaching aids get better the more data the system collects about the individual. When does this data collection become too intimate? These questions are addressed towards the end of the report. How a Norwegian skills reform might look like will be examined in our next report.

INDEPENDENT OF TIME AND PLACE

New online forms of learning mean that we can participate in teaching when and wherever we like at a tempo that suits us. Massive, open and small, closed online courses are examples of how teaching can be made more flexible.

'THE YEAR OF THE MOOC'

In 2011, two professors at Stanford University published one of their introductory courses in Artificial Intelligence freely online. The course, which had previously only been available to registered students, was made available - free of charge - to anyone. When the semester began, more than 160,000 people from 195 countries had registered for the course.[19] The combination of short video lectures, quiz-based assignments and social forums for discussion with others meant that it was easy to participate.

The provision of these courses, known as Massive Open Online Courses (MOOCs) grew profusely over the year that followed. The New York Times declared 2012 as the 'the year of the MOOC'.[20] Most of the major American universities joined the bandwagon, and set about developing - some independently

[19] Haber (2014)
[20] The New York Times (2012)

and others in partnership - platforms through which to offer their courses online. Subjects in the field of Programming, in particular, attracted large volumes of students.

The three biggest ones: Coursera, Udacity and edX

Coursera was founded in 2012 at Stanford University, and currently has around 150 partners globally. This is the biggest MOOC platform, offering more than 2,000 courses and with 30 million registered students. The courses typically last 4-10 weeks and can be followed free of charge, but a small fee is charged if the student requires a certificate of participation. Coursera also offers complete Master's degrees through the platform, n partnership with among others Arizona State University.[21]

Udacity also emanates from Stanford and in recent years has targeted its courses more at working life. The platform offers industry-specific courses and 'nanodegrees' being developed in close cooperation with industry, particularly in the areas of web development and informatics. A nanodegree typically comprises 5-7 courses taken over 6-12 months, and costs around 199 dollars per month. Udacity also offers a full Master's degree in Informatics in partnership with AT&T and Georgia Tech University.[22]

edX was established as a partnership between Harvard University and MIT, and has more than 100 partners globally. edX offers around 1,800 courses and is the second biggest platform with more than 14 million registered students. In addition to offering courses through the edX platform, they have also developed Open edX - an open infrastructure that allows educational institutions all over the world to develop their own courses.

In recent years, MOOC platforms outside of the USA have also grown rapidly. The British platform FutureLearn and China's XuetangX are currently amongst the most popular platforms.[23][24]

MASSIVE AND OPEN

MOOCs can be defined in different ways, but some of the characteristics are recurrent. They are courses that are online, open to all and scalable in terms of the numbers of participants.[25] There is a distinction between synchronous and asynchronous courses:

- **Synchronous courses** involve participants taking part within a certain time frame so that the students progress through the course at

[21] https://www.coursera.org/degrees/master-of-computer-science-asu
[22] https://www.udacity.com/georgia-tech
[23] Class Central (2017)
[24] Class Central (2018)
[25] Norwegian Official Report (NOU) 2014:5 Chapter 2.2, p.10

roughly the same rate. This makes it easier to participate in discussion forums and means that students can provide feedback on each other's work. Many MOOC courses are based on students correcting each other's assignments, known as peer review.

- **Asynchronous courses** have even greater flexibility and can be taken at any point in time. These involve less communication with other students. These are well-suited to courses where assignments can be marked by a machine, for instance in Mathematics or Programming.

Many hoped that the dissemination of knowledge through MOOCs would result in the democratisation of higher education. People around the world would now have access to teaching from prestigious universities where it ordinarily costs a lot of money to be a student.[26] There are good examples of precisely this kind of democratisation. For instance, a study by Coursera showed that participants from developing countries with lower levels of education and socio-economic status often derived concrete career benefits from participation in a MOOC.[27]

However, the analyses also show other trends. The average course participant already has a high level of education and is generally in work. So far, this means that MOOCs have not had the levelling impact on education levels in general terms that had been hoped for. As more user data emerged from the MOOC providers, it also became apparent that up to 90 per cent of students drop out during the courses. These insights led to 2013 being discussed by many as 'the year of the anti-MOOC'.[28]

The percentage that completes a full course is not altogether crucial.[29] The scalability means that the cost is the same, regardless of how many people participate. Despite the large percentages of drop-outs, there still remain a large number of people who complete the courses. Even though 85% of the 160,000 participants in the first Stanford course dropped out once it was under way, there were still 23,000 finishers. By comparison, a normal university course at Stanford will typically have a maximum of 200 students enrolled.[30]

[26] The New York Times (2014)
[27] Harvard Business Review (2015)
[28] Haber (2014)
[29] Slate (2014)
[30] Scientific American (2013)

In the case of MOOCs, it can be helpful to discuss the term 'drop-in' rather than 'drop out'. The motivation for participating in a MOOC is often different from the incentives of participating in traditional education, and you get a lot out of the course even if you do not complete the full programme. For example, a report published by the University of Edinburgh demonstrated that MOOC participants' motivation was connected to learning something new and testing online learning to a greater extent than either qualifications or career.[31]

The fact that learning takes place online also means that large volumes of data are generated, which can help in understanding and improving students' learning. Data-driven learning analytics of this kind makes it possible to open up the 'black box' in teaching and create new opportunities for pedagogical research and development.[32] Analyses of this kind can also streamline course development. It lots of people drop out of module 3 in week 5, it is possible to adjust precisely this part. The development of a MOOC course is therefore not necessarily a one-off investment, but can be improved as additional insights are gained.

The opportunity to develop MOOC-like courses is not wholly limited to universities or colleges either. Platforms like Udemy[33] and Skillshare[34] make it possible for anyone to offer their expertise to others by developing their own course. This can apply to people who, for instance, have skills that are in demand but where the traditional teaching channels are limited. In addition to offering tools for creating their own courses, the platforms also function as a marketplace where course developers set prices and users buy access to individual courses.[35]

SMALL AND COMMERCIAL

Sebastian Thrun, one of the founders of the MOOC platform Udacity, said in 2013 that MOOCs had been good for five per cent of students, but not the other 95 per cent. In the same year, Udacity began to a greater extent to direct its courses at continuing and further education in companies rather than higher

[31] University of Edinburgh (2013)
[32] Koedinger et al. (2014)
[33] https://www.udemy.com/
[34] https://www.skillshare.com/
[35] TIME Magazine (2016)

education - they transitioned from MOOCs to SPOCs (Small Private Online Courses).[36]

Udacity began to offer short, specific courses that could be put together into a nanodegree degree, in areas such as programming or data analysis. The courses were developed in partnership with large companies such as Google, Facebook and Salesforce. Since the courses were developed in partnership with industry, students who completed the courses were well prepared for a job or new tasks in precisely these companies. This focus on learning skills that are directly relevant to work appears to be successful. Far more students complete these courses than in the case of traditional MOOCs.[37] Cooperation with businesses and courses teaching skills that are sought after by the labour market seems to be an increasing trend.[38]

Several large companies have also built their own platforms for online learning precisely so that the content is suited to the tasks to be carried out by their employees. For example, telecommunications company AT&T cooperates with Udacity and Georgia Tech University to develop customised content. Employees are able to take individual courses on AT&Ts dedicated platform that can later be converted into a nanodegree degree or a full Master's degree.[39]

However, the emergence of the Internet and cloud-based services has meant that the skills profile at AT&T has changed dramatically in recent years. The company is now focusing on transforming employees' skills rather than replacing it. Employees are entitled to use ten hours per week to learning activities, and the company covers the costs of any course or degree that is completed. Instead of a career ladder where one works up through the steps, the desire is to promote a career network where employees can move up or down and between different department and fields.[40]

In the Norwegian context, several companies have developed their own platforms for online learning. Examples of this includes Telenor's digital learning portal Telenor Campus,[41] which offers customised courses from the MOOC platform Coursera, and the retailer Meny's digital learning arena Meny Masters[42].

[36] The New York Times (2014)
[37] Business Insider (2015)
[38] EdSurge (2017)
[39] Harvard Business Review (2016)
[40] World Economic Forum (2017)
[41] Telenor (2018)
[42] https://meny.no/Om-MENY/Jobbe-i-MENY/MENY-Masters/

MOOCS IN NORWEGIAN

The first Norwegian MOOC was launched in 2013. NTNU offered the course Technological Change and Social Development in four different editions, including as a free MOOC without exams or physical meetings. The course was taken by 900 students and became NTNU's biggest continuing education course as a result.[43]

That same year, the government set a goal to offer further education to 10,000 Mathematics teachers over the coming five years.[44] As part of this, a 30 credit course in further education in Mathematics 2 was offered as a MOOC, commissioned by the Ministry of Education and Research and on the initiative of the Norwegian Centre for ICT in Education. The course started in the autumn of 2015 with 297 students and was at this time the largest further education course in Norway. Today, around one in ten teachers carries out their further education either wholly or partially through online courses.[45]

[43] Norwegian Official Report (NOU) 2014:5 Chapter 6.8, p. 32
[44] The Norwegian Government (2013)
[45] Conversation with the Norwegian Directorate for Education and Training

MatematikkMOOC
In 2015, a further education course for teachers in Mathematics 2 was offered as a MOOC. MatematikkMOOC consisted of multiple elements that characterise a typical MOOC, including short films and quizzes, as well as elements that were similar to traditional teaching methods, such as group work and supervision meetings with teachers. The year after, a MOOC was also developed for further education of teachers in Mathematics 1.

Both the MOOCs have been evaluated by NIFU and it was shown that around 80 per cent of students completed the courses. These figures are far greater than those from the first wave of international MOOCs. As in the case of Udacity, it can be assumed that when the course is perceived to be directly relevant to one's own work, there are more people who complete it than when the motivation is 'only' based on a general interest in learning something new. NIFU's evaluation also demonstrated that students were satisfied and that the content was perceived to be relevant to their working situation.[46]

At the same time, there were individual elements in the first MOOC, such as group work and supervision in video meetings, that meant that students were unable to study at their own pace. They were dependent on coordinating with other students and teachers, and to a greater extent adapting to a fixed timetable. This meant that the full potential of the technology was not exploited, because elements of traditional organisation and education were retained. These video meetings have been removed from the programme of learning in the second MOOC, and may be one of the reasons why these students were more satisfied with the flexibility of the course.[47]

In 2014, the Green paper 'MOOCs for Norway. New digital learning methods in higher education' was published. The committee were tasked with examining what opportunities and challenges were associated with the growth of MOOCs and similar educational activities. While the development of MOOCs in the USA has been driven forward by venture capital and ambitions to profile specific brands, the motivation in Europe has been largely tied to a desire to raise the quality of education and promote new learning and teaching practices.[48]

The Green paper claimed that technology can provide new pedagogical opportunities and contribute to better and more efficient learning.[49] One of their recommendations was therefore to establish a knowledge environment for learning analytics. Learning Analytics involves the automatic collection and analysis of large quantities of data, where the aim is to understand and improve the learning processes. The recommendation was followed up in 2016 by the establishment of the Centre for the Science of Learning & Technology (SLATE)[50] at

[46] Tømte et al. (2016)
[47] Tømte et al. (2017)
[48] Norwegian Official Report (NOU) 2014:5 Chapter 6.7.3, p. 31
[49] Norwegian Official Report (NOU) 2014:5 Chapter 2.2, p. 11
[50] https://www.slate.uib.no/

the University of Bergen.[51] The year after, Norgesuniversitetet and Fleksibel utdanning Norge issued guidance on the use of digital tools and teaching quality.[52]

In relation to continuing and further education, the Green paper recommended investment in the use of MOOCs. As demonstrated above, there are already some of these in place. One example is the NTNU-developed MOOC ICT in Education, which tackles the pedagogical use of ICT and is aimed at teachers.[53] The Green paper also called for stronger collaboration between industry and educational institutions in order to ensure that MOOCs responded to the skills requirements of industry.[54]

In recent years, there have also been examples of MOOCs integrated as learning tools into traditional campus studies. At OsloMet, a MOOC is included on the syllabus for the programme in Anatomy and Physiology. This consists of around 100 videos, short texts, an e-book and 4-500 tasks.[55] At the University of Stavanger, they have developed an asynchronous and flexible MOOC that is used on its nursing programme. It contains, amongst other things, film demonstrations of practical skills and is a good reference work for students in practice.[56]

Despite the presence of successful individual courses, the range of Norwegian MOOCs remains fairly limited. At present, mooc.no acts as a portal for all MOOC-inspired courses offered by Norwegian universities and colleges.[57] The portal does not provide a complete overview, but has around 30 courses. More than one third of these have been developed with support from Norgesuniversitetet.[58] By comparison, Coursera, the biggest MOOC platform, currently offers 2,000 different courses.

Over the course of several years, Norgesuniversitetet's *Digital tilstand* has demonstrated that work to start using digital tools in Norwegian educational institutions has been dependent on enthusiasts and has lacked any firm support at a management level.[59] In their study, last carried out in 2014, just two per

[51] Ministry of Education and Research (2017)
[52] Fossland and Ramberg (2017) and Fleksibel utdanning Norge (2017)
[53] https://www.ntnu.no/iie/mooc
[54] Norwegian Official Report (NOU) 2014:5 Chapter 14.5, p. 82
[55] Vikestad (2017)
[56] Strømme et al. (2017)
[57] https://www.mooc.no/
[58] Koch and Bakke (2017)
[59] Ørnes et al. (2015)

cent of professional employees stated that MOOCs were a key priority at their institution.[60]

Professor Arne Krokan, who was responsible for the first Norwegian MOOC, highlights that developments in Norway so far have been driven by a handful of enthusiasts, with little professional support from their own institutions. He refers to a range of barriers to the development and operation of a MOOC at present, including those connected to incentives, digital infrastructure, legal issues and skills.[61]

This year's situation report for higher education indicates that digitalisation work is currently in the process of becoming more clearly strategically anchored within institutions.[62] Nevertheless, forms of learning like MOOCs have not taken off in Norway. The fact that education is generally free of charge in Norway, in contrast to a country like the USA, may be part of the reason why. Other explanatory factors include the lack of investment and incentives. This was called for by the MOOC committee, both at a national and institutional level.[63]

[60] Ørnes et al. (2015)
[61] Krokan (2017)
[62] Ministry of Education and Research (2018)
[63] Norwegian Official Report (NOU) 2014:5 Chapter 3.1, p. 12

PERSONALISED

Adaptive learning and learning analytics means that teaching and assignments can be adapted to each individual participant's level and needs on an ongoing basis. The system is therefore able to function as a digital assistant to each individual.

Learning adapted to each student and individual follow-up has long been a goal in schools. This means that teaching should be facilitated and adjusted so that it works well for all students. Learning analysis is based on automatically gathering and analysing data to understand improve students' learning. This means that teaching can be adapted in ways other than those that have previously been possible, both within the education system and in the workplace.

RESPONSE AND ADAPTIVE SYSTEMS

Personalised learning is a broad term that relates to teaching being adjusted in one way or another to respond to the individual level, needs and goals of each student. Within digital teaching aids, there are different degrees of personalisation. This can range from a simple adjustment to a user interface to a system

that is continuously adapting the content shown based on the user's performance. We make a distinction in this regard between responsive and adaptive learning systems.[64]

Responsive systems can be very simple. For example, they may involve students choosing colours or a personal avatar in the learning software, or administrative teaching assignments being adapted or automated, for instance through a digital learning platform (LMS).

Several systems that are marketed as adaptive have been criticised for supplying only pre-programmed learning paths. For example, there may be systems where a fixed learning path is prescribed to each participant after a one-off evaluation, or where the same finalised modules are suggested to everyone with the same answer to an assignment in the next round.[65] Data-driven systems like this also fall under the responsive category.[66]

There are adaptive systems that have received a lot of attention in recent years. In these, data is gathered and analysed on an ongoing basis in order to offer individual support in real-time. The system is therefore able to move past pre-programmed learning paths. This means that the teaching can be adapted on a continuous basis to each individual student's behaviour, needs and learning style, and in many cases this involves the use of machine learning.[67]

In the long term, there are great expectations related to such systems being able to provide socially intelligent and inspirational guidance, which - through the use of tools such as facial recognition - can also respond to students' emotions and mood.[68]

[64] Bulger (2016)
[65] EdSurge (2016)
[66] Bulger (2016)
[67] EdSurge (2016)
[68] Bulger (2016)

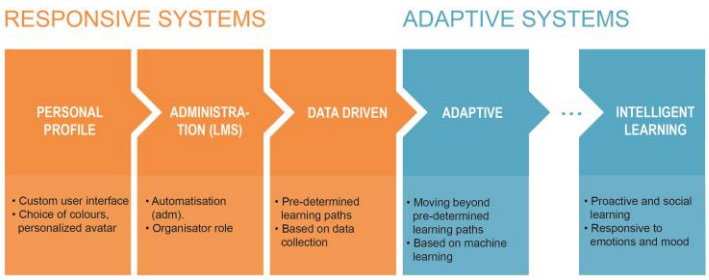


Figure: For each category, the adaptability of the system increases. Based on Bulger (2016).

ONE TEACHER PER STUDENT

Digital learning material gather large quantities of data about students. This can include the number of assignments they complete, time spent and the kinds of mistakes they make. Adaptive learning aids analyse this data in order to adapt the content to the students' individual needs.

Adaptive learning material make continuous assessments of students' performances so that the degree of difficulty of assignments can be adapted on an ongoing basis to each individual. If a student makes a lot of mistakes, the assignments will be made easier until the student gets to grips with the subject. If the student answers all assignments correctly, the level is raised in order to further challenge the student.[69]

[69] EdSurge (2016)

Instead of providing the student with feedback as to whether an answer was right or wrong after all assignments are resolved, immediate feedback and advice is offered while under way. This is supposed to help the student to understand *what* went wrong. This can also allow for the ongoing evaluation of the student's level and challenges instead of using a final exam towards the end of the term.[70]

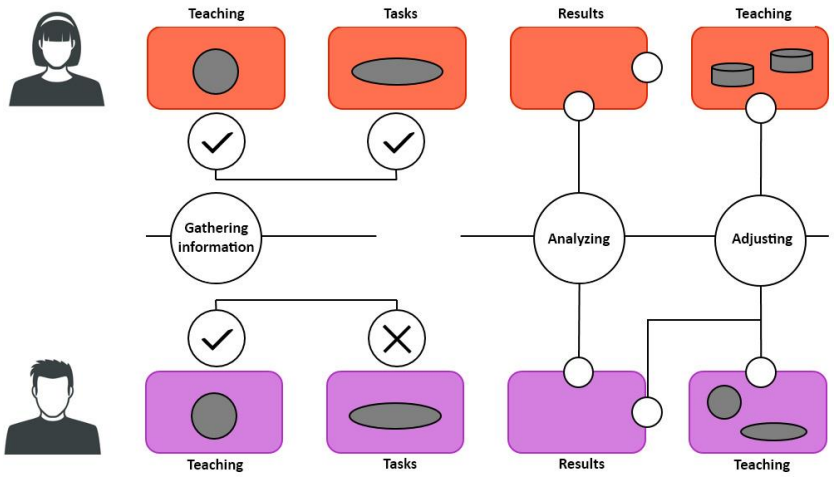


Figure: While one student continues to more advanced geometry, another is provided with a refresher in basic shapes. Based on EdSurge (2016).

In 2009, Education researcher John Hattie published an extensive meta analysis of which factors contribute to better results for students. The interaction between teacher and student and frequent and relevant feedback were the factors that generated the greatest effect.[71] Adaptive systems can strengthen the teacher's ability to provider closer follow up, and to understand exactly where the issues lie for each individual. In this way, the system is able to function as a kind of digital assistant teacher to each teacher and student.

[70] The Norwegian Board of Technology (2017)
[71] Hattie (2009)

Ten Million Data Points
Knewton is one of world's leading companies in adaptive learning and learning analytics. They state that they collect up to ten million data points about each student - every single day.[72] In 2011, Arizona State University began using educational software provided by Knewton. The goal was to boost the mathematical skills of their first year students. The university found that up to one third of students got grades below a C, which increased the risk of them dropping out of their studies later on. After one year, drop outs had more than halved, and the proportion who graduated had increased by more than ten per cent.[73] Thanks to a collaboration with Gyldendal, algorithms from Knewton are also used in Norwegian schools.[74]

InBloom: Privacy and Data Processing
2013 marked the launch of InBloom - a non-profit supported by organisations including the Bill and Melinda Gates Foundation. The goal was to create a common infrastructure where public schools in the USA could come together and store data in a standardised way in order to - amongst other things - offer personalised teaching programmes. After approximately one year of operation, school after school began to pull out until the company had to be wound up. There were multiple reasons for closure, but the handling of data about students was a key element. As it was impossible to opt out of the data collection, many parents felt the technology got too close to their children.[75]

BETTER BASIS FOR LEARNING

Data analysis can also be used to create the best possible basis for learning. In this case, different types of data are collected and analysed to better facilitate participants' other plans and obligations.

Arizona State University uses data analysis to get more students to complete their studies. Amongst other things, they use tools that create custom schedules for each individual. This allows students to include courses that are mandatory for their programme, they receive suggestions of other relevant courses, and the schedule is adapted to their personal life - for example, if they have children

[72] Politico (2014) and NPR (2016)
[73] Mayer-Schönberger and Cukier (2014)
[74] https://multi.smartoving.no/
[75] Bulger et al. (2017)

who need collecting from nursery before a certain time. In addition to facilitating the individual needs of students, such tools have - according to the university - contributed to 20 per cent more students completing their studies.[76]

PERSONALISATION IN WORKING LIFE

Adaptive learning is rapidly gaining traction in schools. Similar use of data-driven systems is also becoming common in other areas. Germany's Bundesagentur für Arbeit (the Federal Ministry for Labour and Social Affairs) uses data analysis in order to offer advice and measures suited to the individual job seeker's skills and needs. In this case, they analyse historic data about the user, their unemployment history, which initiatives were implemented and what results these generated, and how long it took to find suitable employment.[77]

Personalisation also offers new opportunities for learning in working life. One challenge can be to set aside time for learning activities in addition to the ordinary tasks that have to be carried out. In the same way that students at Arizona State University receive personalised schedules, data analysis can help to customise training and courses based on employees' calendars and work duties. Algorithms can evaluate which tasks must be done by certain points, and which ones are more flexible. In this way, it is possible facilitate training and education without it necessarily obstructing daily work.

This can also be useful if learning about a new computer system or new processes. Training can be adapted so that you do not have to go over things you already know, or avoid starting at too advanced a level. It can also be used to ensure that employees have sufficient skills in critical areas. For instance, in the Armed Forces necessary skills are defined and measured using various data and metrics, where each skills-based form of training is used to adapt the education of each individual.[78]

Nano degrees, which were developed by the Udacity[79] platform, are becoming increasingly popular. One of the reasons for this is the opportunity to adapt content to the specific business. Instead of sending employees on general courses, you tailor the content to tasks that the employee actually deals with in

[76] The Atlantic (2016)
[77] The Norwegian Board of Technology (2017)
[78] Conversation with the Norwegian Defence Research Establishment
[79] https://www.udacity.com/nanodegreedegree

their daily working life. The potential for this kind of learning is tremendous and can provide a right-on-time approach to skills. Employees can be granted access to small training modules when they need it, and you can update the courses constantly based on the needs of the company.

SIMULATED

With digital simulations, programmes of learning can be closely tied to actual work tasks and situations. The use of gamification can also increase the motivation to learn.

Digital simulations are becoming increasingly widespread in learning contexts in working life. This can be described as a digital version of a process or a system in which the participants carry out tasks as if they were in a real work situation.[80] Flight simulators are a familiar example, in which pilots practice flying without exposing themselves and others to potentially dangerous situations. Some of the benefits of using simulation are precisely that you can practice tasks that are new, complex, dangerous or that rarely occur, and that can be very time-consuming and expensive to provide training for.[81]

When using simulation in teaching, you can train for situations that are closely related to the actual working environment and the specific tasks that need to be performed. For example, advanced dolls have been used in nursing training for many years so that students can train for specific situations they will deal with in their work. When learning is simulated, the user is also provided with the opportunity to try different approaches for handling a task, thus enabling them to discover what will be likely to work best in reality.[82]

[80] Gegenfurtner et al. (2014)
[81] Lateef (2010)
[82] Sheffield Hammond University (2014)

It is now possible to create detailed digital simulations quicker and cheaper, including of larger and more complex systems.[83] This can be used both for training purposes and for real-time guidance in specific working situations. Simulation can be used in many ways: from 2D and 3D models on a PC or mobile to more complex simulations that involve the use of virtual, augmented or mixed realities.

VIRTUAL, AUGMENTED AND MIXED REALITIES

Virtual Reality (*VR*) takes the user into a different reality to the one they exist in. In recent years, several of the major technology companies have been working to develop virtual reality glasses. Some, like HTC and Oculus, offer equipment that requires lots of capacity for data processing and graphics. Others, like Google and Samsung, have developed simpler versions where you insert a smartphone into a case. The cheapest versions are made from cardboard and cost around NOK 50.

Virtual reality can be used in situations such as getting to know a new working environment or training for tasks that require some physical capabilities.[84] For example, the company Osso VR develops programs in which surgeons can train for specific operations.[85] At NTNU, students can train for operations, procedures and collaboration with others in a virtual hospital environment.[86]

Augmented reality (*AR*) does not simulate another reality or another place but provides the user with an extra layer of information or graphics on top of the place they are. Many people probably had their first experience of augmented reality through the popular game Pokémon Go. Using the camera of a smartphone, it was possible to see Pokémon characters in your surroundings. There are also multiple tourist apps that allow you to hold the camera on a phone up to a building and receive relevant facts.[87]

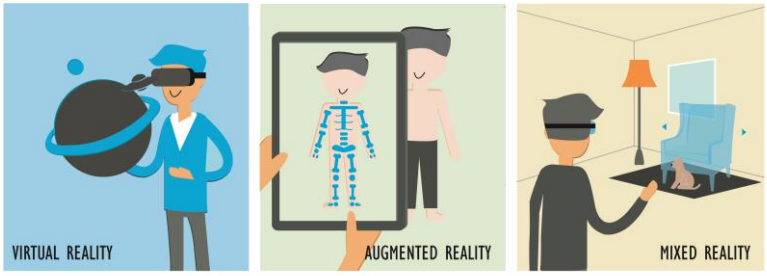
Augmented reality can be used for purposes such as providing information and guidance in real-time. For example, the aircraft manufacturer Boeing uses

[83] FFI (2016)
[84] World Economic Forum (2017)
[85] http://ossovr.com/
[86] Teknisk Ukeblad (2017)
[87] For example Yelps Monokkel

glasses that provide factory employees step-by-step instructions on how to fit components.[88]

Mixed Reality (*MR*) weaves reality and virtual reality closer together. Digital objects are anchored into the surroundings instead of being added as an extra layer, with the virtual and physical environments interacting in real-time.[89] Some mixed reality glasses allow the user to communicate with the virtual objects via voice commands, hand movements or the direction the user looks.

In partnership with Microsoft, Case Western Reserve University uses mixed reality as part of its teaching in Anatomy. By using HoloLens glasses, a virtual human body can be projected into the room. A hand gesture allows for the body to be rotated, muscles added to the skeleton, or an organ to be taken out of the body for closer examination.[90]



REALITY ORIENTATION

Despite major investments and multiple product launches in recent years, glasses for virtual, augmented and mixed realities have not become commonplace.

According to a new study by the company Perkins Coie, price is one of the key reasons behind this. Nevertheless, this concern seems to have become less crit-

[88] The Economist (2017)
[89] Wired (2016)
[90] http://case.edu/hololens/

ical in the last couple of years, with the announcement of price cuts for equipment and the launch of more affordable alternatives potentially being part of the reason for this.[91]

The user experience is considered to be the greatest challenge faced by both virtual and augmented reality.[92] Technical limitations and impractical equipment, for instance the need for large glasses or a connection to external sensors and a powerful PC, are amongst the concerns. Several companies are now working to develop free-standing glasses that do not need to be connected to either a PC or smartphone.[93]

Nausea when using virtual reality glasses, known as *virtual reality sickness,* has also proven to be a barrier. This means that it is still not comfortable to use glasses like this over longer periods of time.[94] The fact that one's surroundings are completely shut off, unlike when using augmented and mixed reality, has also been highlighted as a weakness, amongst other things because it is perceived to be anti social.[95] Perkins Coie's study shows that 81 per cent of people think that development will now be aimed at more social experience and collaboration.

The use of augmented and mixed reality does not necessarily require glasses or other supplementary equipment, but can be used on a normal smartphone. This lowers the barrier for use.[96] One example of this is the game Pokémon Go, which was downloaded more than 500 million times in a short period of time.[97] Many have therefore stated that the smartphone, which most people carry with them at all times, will be at the heart of developments over the coming years.[98]

While games and entertainment have long driven development, education is now emerging as one of the most promising applications.[99]

[91] Perkins Coie (2018)
[92] The study does not classify mixed reality as a separate category.
[93] Wearable (2018)
[94] Fortune (2018)
[95] Forbes (2017)
[96] Mashable (2018)
[97] TechCrunch (2016)
[98] Digi-Capital (2017)
[99] Perkins Coie (2018)

EXPLORING AND LEARNING

Exploring new environments and places is a popular application for simulation. For example, several schools use simple virtual reality glasses to teach History or Geography. The program Google Expeditions allows students to see and explore different places around the world, which can seem more engaging than reading about them in a book.[100] Multiple studies also show that the use of augmented reality in teaching situations can help contribute to better student motivation and results, especially for those with weak skills.[101]

Initial experiences from the project VR Education have shown similar results. An ongoing pilot project in Norwegian schools is testing the use of virtual reality in the teaching of Maths. The results to date show that the weakest students are lifted by around 50 per cent when teaching is made more visual, while students are lifted on average by 30 per cent.[102]

Simulation has also been used in the workplace to explore new environments. When the new terminal at Oslo Airport was due to open in 2017, the Norwegian company Attensi developed a simulation of the terminal. This enabled employees to familiarise themselves with their new working environment before it came into use. The simulation was a 3D model of terminal, and users were provided access via a PC or tablet. The simulation was designed as a game in which employees could move around the model and deal with realistic tasks such as answering questions from passengers or dealing with unattended luggage. Playing the game was mandatory in order for employees to receive an access card for the new terminal.[103]

IMMEDIATE ACCESS TO KNOWLEDGE

In 2015, Google discontinued its investment in Google Glass smart glasses for the consumer market. The glasses, which were able to show emails and messages on the lenses themselves, had been heavily criticised on privacy grounds

[100] Statped (2017)
[101] Salmi et al. (2016)
[102] Abelia (2018)
[103] TV2 (2016)

and due to a lack of practical applications.[104] Work on the technology itself was not discontinued, and in recent years it has been implemented in workplaces around the world. The use of augmented reality makes it possible to obtain immediate access to relevant information when it is needed, without having to look something up in a manual or instruction book.

The American company AGCO, which manufactures tractor engines, uses Google's smart glasses to provide its factory employees with immediate access to descriptions of processes and equipment used in production.[105] The camera on the glasses can identify which parts of the engine the employee is working on, and then - for example - shows pictures of how the parts should be fitted.[106] The technology therefore enables on-demand learning when the individual needs it. This can make learning easier, and save the company a lot of time. The employee can be led through new processes or systems the first few times, and then receive support later on if there is anything they are unsure of.

Another example is elevator repairers working for the German engineering company Thyssenkrupp, who use Microsoft's HoloLens both prior to and during assignments. The glasses provide the employee with immediate access to technical specifications, training videos and details of which tools to use for different components. Colleagues with specialist knowledge can also be connected into the glasses via Skype to offer real-time guidance to the repairer, for instance through marking important details or providing instructions on the right tools to use.[107]

GAMIFICATION: MOTIVATING MORE AND BETTER LEARNING

Gamification is about the use of design elements and principles from games in situations outside of gaming contexts.[108] This can involve the use of graphics, narration and levels, as well as rewards in the form of points, sounds, rankings or virtual prizes. This makes it possible to experience various situations, such

[104] The Norwegian Board of Technology and Norwegian Data Protection Authority (2015) and Engadget (2017)
[105] Wired (2017)
[106] Harvard Business Review (2017)
[107] Microsoft (2016)
[108] Deterding et al. (2011)

as a learning context, as being more like a game. The quiz-based learning platform Kahoot! is an example of this.[109]

Multiple studies show that gamification can have a positive impact on both motivation for and the results of learning activities.[110] Motivation for learning can increase when it seems fun, and exercises can be repeated to ensure that knowledge is retained better. Immediate feedback and competitive elements can also provide a feeling of success and mastery during the course of learning. By comparison, traditional learning can be more difficult to feel motivated about, with employees often having to stop work to participate or where there is no opportunity to repeat the activity.

The company Attensi has developed several games that are used for training in retail companies such as Spar, Europris, Skeidar and Kid Interiør. The games are designed as 3D simulations of the chain's stores. Employees can navigate around them on a mobile or PC, and receives points for activities such as putting goods on half-empty shelves, fixing bottle return machines, greeting customers and responding to questions.[111] Attensi has also developed game-based simulations for training on software, which allows users to be certified through scoring highly enough. Game developers, copywriters and psychologists were involved in the design in order to provide the best possible motivation and learning outcome.[112]

Kid Interiør

A training game developed by Attensi provides Kid Interiør employees training on their stock through a quiz and simulated conversations with customers. Participants are rewarded with points, and there is a competition between colleagues and stores to achieve the highest ranking. Knowledge of a range of products traditionally involves a lot of cramming, which it can be difficult to feel motivated to do. The game meant that stores experienced an increase in motivation to learn - even though employees were only paid for one hour of training, each individual spent an average of 10 hours playing. In some stores, the average game time was a total of 17 hours. The training appears to have had a noticeable impact on additional sales.[113]

[109] https://kahoot.com/
[110] Hamari et al. (2014)
[111] https://attensi.com/
[112] Dagens Næringsliv (2017)
[113] E24 (2016)

As part of a pilot project, Hydro has collaborated with Sintef, Attensi and Cybernetica to develop a computer game for training operators in the aluminium industry. With shifting skills requirements as a result of digitalisation and automation, the game is intended to help operators to master new and necessary skills and tools. The plan is that the game will eventually be included in training programmes at all of Hydro's metalworks.[114]

Østfold Hospital Trust
When Østfold Hospital Trust's new hospital was under construction, a game-based learning tool was used to provide training to employees. The game was designed as a 3D simulated version of the new building. Staff were able to navigate around the inside of the hospital's 85,000 square metres from a PC and get to know what was in the different corridors, rooms and cupboards prior to them being physically on site. This allowed staff to train on carrying out their role in a completely new environment, including taking care of simulated patients and through virtual conversations.

This training was to enhance patient and staff safety and confidence through training for critical situations in advance through a separate module designed for the emergency room. One challenge with the tool was that several employees without any gaming experience found it difficult to use. However, this improved with practice.[115]

[114] Dagens Næringsliv (2017)
[115] Teknisk Ukeblad (2014)

TECHNOLOGY AND LIFELONG LEARNING: POTENTIAL AND CHALLENGES

New learning technology can provide adults with the opportunity to develop their skills in line with changes to working life. This requires us to resolve the challenges related to inequality, pedagogy and personal privacy.

The goal of the government's announced skills reform is that no one should go out of date - we have to learn throughout our lives if we are to be qualified for a working life in change as the result of digitalisation and new technology.[116] In this report, we have shown how the same technology that is changing jobs as we know them also presents new opportunities for learning.

[116] The Norwegian Government (2018)

ADULTS LEARNING

Individual motivation is an important dimension of learning. What motivates adults to learn is not necessarily the same as in children and young people. This is why it can be important to approach lifelong learning innovatively - pedagogy and technological aids must potentially be used differently in the workplace than they are in school situations. For example, in Singapore teachers are trained in how to deal with adult students as opposed to pupils in the school system.[117]

Malcolm Knowles is often referred to as the father of adult education. He stated that adult learning distinguishes itself from children's learning in several respects. In the 1980s, he presented four assumptions about adult learning:[118]

- Adults are self-directed students. They should therefore always be involved in the planning of teaching and learning plans.
- Adults' experiences are a learning resource. Teaching should therefore be based on and open to discussion of personal experiences.
- Adults' motivations for learning are often triggered by a specific need. Teaching should therefore be perceived as immediately relevant to their life or work.
- Adults are problem-oriented students. Teaching should therefore be directed at specific issues rather than general themes.

In the White Paper 'Fra utenforskap til ny sjanse. Samordnet innsats for voksnes læring' [From Outsiderness to New Chances. Coordinated Efforts for Adult Learning] principles along these lines are also presented. Adults' motivation for learning is often connected to what significance it might have on achieving better working conditions in their current job or opportunities relating to the job market. One characteristic of a successful initiative is therefore that learning is based on adults' working situation and that it is adapted to the needs and challenges that adults typically experience in their working or private lives.[119]

[117] World Economic Forum (2017)
[118] Blondy (2007)
[119] White Paper 16 (2015-2016), Chapter 3.1, p. 29

In purely schematic terms, the potential for complying with Knowles' four principles for adult learning through the use of new technology can be shown as follows:

Principles for Adult Learning	**Potential for Technology**
Involvement in Planning of Teaching	• When it can take place independent of time and place, participants should be involved in the **planning** of teaching - they should decide when and where they want to participate, and at which pace. • Examples: MOOCs and SPOCs, but also adaptive learning tools and simulations that can be accessed anywhere and any time from a PC, mobile or tablet. • By collecting different types of data, the learning plan can be **adapted** to participants obligations in their work and private lives, which was shown with the example from Arizona State University.
Based on Own Experiences	• By using simulations and games, participants can **gain experiences** through trying and failing, and testing what works best in different situations. • By using social forums such as chat and virtual colloquia, participants can **exchange and discuss** their own experiences.
Immediately Relevant	• Learning can be connected closely to **real working situations** that are directly relevant to participants' jobs, for instance by using simulations or SPOCs. • Augmented and mixed reality can provide relevant instructions and **guidance in real-time**. • Teaching can be made immediately relevant to each individual participant's level and needs through the use of adaptive learning.

Specific Rather Than General	• Learning can be tailored to a **specific task, process or workplace** rather than general themes, as demonstrated by SPOCs and simulations. • Examples: Udacity's company-oriented course, Hydro's game for operators, Oslo Airport's simulation of their new terminal.

EQUAL ACCESS AND EQUAL OPPORTUNITIES?

Norway scores high in surveys mapping the provision of and participation in learning compared with other countries.[120] Results from the Lærevilkårsmonitoren survey show that around 8 per cent of the population participated in formal further education in 2017. Around 40 per cent participated in a form of non-formal learning, which was job-related in more than 90 per cent of cases. Although not all Norwegian employees participate in organised learning, around 80 per cent say that they have good opportunities for learning in their daily work. However, in recent years, the proportion of participants in both formal further education and non-formal learning have decreased.[121]

There is a positive correlation between education and work - increased skills offer better opportunities on the job market. At the same time, there are differences visible in terms of *who* participates in education and training. Studies of adult learning show the so-called Matthew principle. People who already have higher education participate in more learning than those with lower education.[122] The fact that most people learn new things through work also makes it more difficult to be unemployed. When you do not have a job, you do not have access to the workplace as a learning arena.

It is a political goal that everyone should have the opportunity to develop their skills.[123] As we have seen in the case of the MOOC, the use of technology can enhance the bias in participation as the average course participant is already in work and highly educated.[124] However, this bias is not a necessary consequence

[120] See, for example, Tømte et al. (2015)
[121] Keute and Drahus (2017)
[122] SSB (2017) and Keute and Drahus (2017)
[123] The Norwegian Government (2018)
[124] The New York Times (2014)

of technology, but reflects known structures in society. New learning technology can also make skills development more accessible to more people.

One of the government's goals is to ensure that better learning is available for adults with weak basic skills, with the development of an online low-threshold course being one of the initiatives. Reference is made to positive experiences with such courses in Ireland and Germany, where one explanation may be that the use of technology differs positively from experiences of traditional schooling.[125]

At the same time, the relationship between what people know and do not know varies more between adults than in children and young people. This is why it is important that teaching is aimed at the needs of the individual.[126] Adaptive learning offers new opportunities to achieve this. Learning material can be adapted to each individual participant and can provide continuous supervision, which can in turn increase the motivation for further learning.

Adapted Norwegian Learning
The company Sounds Good and researchers at NTNU have developed a native language app for learning Norwegian. People with different native languages face different challenges when learning Norwegian. students from Somalia, for instance, face completely different challenges in terms of sounds compared to students from China. According to the company, the app is the first language training programme to take this into account. You can choose from 77 different native languages and six Norwegian dialects, and the app offers language exercises at four levels.[127]

DRIVEN BY PEDAGOGY OR TECHNOLOGY?

The use of technology does not in itself lead to better learning, but requires a conscious pedagogical strategy.[128] In many cases, the use of PCs and tablets has been disruptive in teaching situations, and used only to a small extent to

[125] White Paper 16 (2015-2016) Chapter 3.9.2, p. 46
[126] White Paper 16 (2015-2016) Chapter 3.1, p. 31
[127] Forskning.no (2018)
[128] Morgan et al. (2016)

strengthen the pedagogical dimension.[129] A consistent pattern is that technology is adapted to traditional teaching practices, without challenging established ideas. Thus, the full potential of technology fails to be realised.[130]

Monica Bulger of the Oxford Internet Institute has argued that teachers and education researchers are often involved too late in the process of developing adaptive and other digital teaching aids, if at all. At the same time, she points out that at present there is little research into the quality and learning outcome beyond the descriptions provided by the technology companies themselves.[131]

There can be substantial variations in the quality of MOOCs. The design of successful courses requires a combination of technological and pedagogical expertise, and hybrid expertise of this kind is a rare commodity at present.[132] The committee responsible for the Green Paper 'MOOCs for Norway. New digital learning methods in higher education' concludes that it is necessary to strengthen digital expertise related to teaching in employees working in the university and college sector.[133] The committee also emphasised the need to obtain more knowledge about the pedagogical and learning-related aspects of technology. Data-driven learning analysis can be a valuable tool in this work.[134]

DESKILLING?

The term 'deskilling' is often used about processes where the skills required in a profession or industry are systematically degraded through tasks being broken down into smaller components.[135] This is often used in contexts where technology reduces the need for competent, skilled labour, as was the case in craftsmanship following the introduction of the assembly line.

The engine manufacturer AGCO provides its employees with real-time instructions and guidance by using glasses to provide augmented reality. The technology enables on-demand learning that can save the company and its employees a lot of time and resources. At the same time, it also opens up the way for

[129] The Norwegian Board of Technology (2012)
[130] Lillejord et al. (2018)
[131] Bulger (2016)
[132] Krokan (2017)
[133] Green Paper (NOU) 2014:5 Chapter 10.5.3, p. 59
[134] Norwegian Official Report (NOU) 2014:5 Chapter 10.5.3, p. 60
[135] See, for example, Wood (1981)

knowledge to be made superfluous by being continuously provided with instructions on exactly what to do. What consequences will this have on innovation and skills development in the long term?

Technological changes have historically led to greater need for high levels of expertise, not less.[136] Several of the learning technologies we have described in this report facilitate short and targeted learning when it is needed. This will become problematic if it is at the expense of developing more general skills, such as problem solving, critical thinking and social and creative capabilities. It is these skills areas in particular that experts have highlighted as the most important for employees of the future, and in order to transition in a job market in change as a result of new technology.[137]

DOCUMENTATION OF SKILLS?

A learning-intensive working life and new digital forms of learning mean that there is not always a diploma or course certificate for the knowledge you have obtained. How can you balance the flexibility of new forms of learning with the need for documentation of skills?

Digital open badges have in recent years become a popular example of an alternative form of documentation.[138] Each badge communicates a skill that have been obtained from a range of different channels, for instance from a MOOC or a game, or from training in a company. Anyone can issue or receive badges, which provide information about who has issued it to whom and what they have done to receive it. It can also include digital evidence so that the skill can be verified.[139]

The idea is to provide a more complete and dynamic overview of a person's skills by recognising learning that occurs beyond the traditional education system. In Germany, for instance, digital badges are being used in a pilot project to enable refugees to demonstrate knowledge from their home country.[140] In the USA, it

[136] Autor (2015)
[137] See, for example, Ananiadou and Claro (2009)
[138] Norwegian Official Report (NOU) 2014:5 Chapter 8.3, p. 43
[139] https://openbadges.org/
[140] The Chronicle of Higher Education (2016)

is used to provide youths documentation of participation in informal learning.[141]

Some have also identified new opportunities in the form of blockchain technology. For example, at MIT they have established an open blockchain to issue, display and verify diplomas.[142]

PRIVACY: THE ELEPHANT IN THE CLASSROOM

Artificial intelligence requires large quantities of data to provide us with personalised learning. Knewton, one of the world's leading companies in adaptive learning and learning analytics, states that they collect up to ten million data points about each student every single day.[143] IBM in Norway has advocated the introduction of a 'learning journal' that will follow each individual from nursery until the completion of higher education, in much the same way as a patient's medical records.[144]

In connection with the MOOC Green Paper, the Norwegian Data Protection Authority has emphasised that there are limits to how much personal information places of study and employers can demand that students and employees surrender. This particularly applies if information is sold to third parties. Amongst other things, they suggested a financial model that prevents practices in which personal data become a means of payment.[145]

Privacy and data processing are an important part of the discussion when introducing new technology, whether it is in schools or in the workplace. The EU's new General Data Protection Regulation attempts to address several of these issues and introduces new and strengthened obligations and rights for companies and users. This means, among other things, that there are requirements for privacy-friendly standard settings, the right to access and control one's own data, and to be forgotten.[146]

[141] Toplic (2016)
[142] MIT Media Lab (2016)
[143] Politico (2014) and NPR (2016)
[144] Khrono (2017)
[145] The Norwegian Data Protection Authority (2014)
[146] https://gdpr-info.eu/

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