Chapter 13
Technology-Enabled Assessment and Improvement of Inclusive Learning and Quality of Life in Higher Education

Maria Toledo-Rodriguez and Thomas Boillat

Introduction

Universities have, for centuries, been the sources of wisdom and knowledge. In order to acquire this knowledge students used to travel to the universities where lecturers, masters in their field, would impart their teachings. Often the transfer of knowledge consisted in masters giving hour's long monologues while the students passively listened and took notes. In order to be successful, this system requires from the student to: (a) attend to all learning sessions, (b) be able to record all the knowledge provided while listening to the lecturer and (c) understand and put in context (within their applications and implications) all information passively received during that unique offering of knowledge. This system puts in clear disadvantage many students who have learning differences, suffer from poor physical or mental health or have additional family/work commitments. Quality of higher education is recognized by researchers and governments to impact the student's quality of life in the long term [1, 2]. The term "inclusive learning" is currently being widely used by academics and governments as a tool to improve the learning in those populations and therefore potentially improve the long-term quality of life of these students and dependants. However, inclusive learning as described by May and Bridger"… *necessitates a shift away from supporting specific student groups through a discrete set of policies or time-bound interventions, towards*

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equity considerations being embedded within all functions of the institution and treated as an ongoing process of quality enhancement" [3]. In the following subsections we define the current technological solutions to enable holistic inclusive learning.

This book chapter presents results of a study employing mixed methods and will focus on the role of different digital technology platforms in supporting assessment and improvement of inclusive learning in higher education. However, it does not systematically focus in detail on software specially developed to help students with learning difficulties. Rather, it presents and analyses recent advances in learning technologies that bring opportunities for inclusive learning and enable individuals to tailor the learning experience to their needs and abilities regardless of their degree of disability. Most of these platforms analyzed in here are relatively recent and while they charge per use, the majority also have a free version, which enables any educator to make use of them (with some limitations), as long as students and teachers have internet connection and a mobile device. In this chapter, we present results of our analysis and discuss design implications for technologies, which, if implemented effectively, will influence the assessment and improvement of learning and attainment of educational goals, as well as quality of life in the long term of any student.

Current Assessment Methods for Cognition/Executive Function, Attention, Memory and Learning in Healthy Populations

Before focusing on digital platforms that enable inclusive learning, we should take a quick look at the current assessment methods of cognition, executive function, including attention and memory and learning in healthy populations. The list of currently used tests used is very large and describing it into detail would take us away from the focus of this chapter. Table 13.1 describes a representative number of tests for executive function, attention, intelligence and different types of memory and academic resilience. We focused on tests that measure performance (PerfRO) [32]. Regarding learning, the best methods to test healthy populations are current academic assessments (e.g. written exams, coursework, oral presentations, group presentations, etc.).

Table 13.1 Representative listing of tests commonly used to measure attention, memory, executive functioning and intelligence

	Scale name (sub-scales)	Consist in	S[a]
Executive function	Behavioral Rating Inventory of Executive Function (BRIEF)	Measures executive function impairment (mainly in children)	[4]
	Covert Orienting of Attention Task	Measures the ability of mentally shifting one's focus without moving one's eyes.	[5]
	Go-No-Go Test	Assesses inhibitory control and cognitive processes needed to stop a movement after being initiated (based on a new stimulus received) The participant has to respond to one of the choices but also has to withhold the response to the other alternative.	
	Ross Information Processing Assessment (RIPA) (Organization, Problem Solving, Abstract Reasoning)	Profiles 10 key areas in communicative and cognitive functioning: Immediate Memory, Recent Memory, Temporal Orientation (Recent Memory), Temporal Orientation (Remote Memory), Spatial Orientation, Orientation to Environment, Recall of General Information, Problem Solving and Abstract Reasoning, Organization, and Auditory Processing and Retention.	[6]
	Ruff 2 and 7 Test (Digits)	Measures visual selective attention utilizing different distractor conditions.	[7]
	Stroop Color/and Word Test (SCWT)	Measures the ability to inhibit cognitive interference between two stimulus mismatch between the name of a color and the colour it is printed on (e.g. the word "pink" colored in blue. When asking what is the colour of the word it takes longer and people make more mistakes).	[8]
	Trail Making Test (TMT)	Measures visual attention and task switching (search and processing speed, mental flexibility and executive functioning).	[9]
	Verbal Fluency Test (FAS)	Measures the ability to produce as many words as possible either within a certain semantic category (category fluency) or starting by a specific letter (letter category) within a set time	[10]
	Wechsler Adult Intelligence Scale (WAIS) Similarities	Measures multiple cognitive abilities and intelligence in adults.	[11]
	Wisconsin Card Sorting Task (WCST)	Measures perseverance, abstract thinking and set shifting.	[12]

(continued)

Table 13.1 (continued)

	Scale name (sub-scales)	Consist in	S[a]
Attention	The Attentional Control Scale	A self-report questionnaire that measures individual differences in attentional control.	[13]
	Continuous Performance Task (CPT)	Measures sustained and selective attention. Individuals must maintained attention while performing repetitive and boring tasks.	[14]
	Dot Probe Task (DPT)	Measures selective attention and attentional biases.	[15]
	d2 Test of Attention	Measures selective and sustained attention and concentration of subjects.	
	Digit Symbol Substitution Test (DSST)	Measures associative learning. Consist on matching symbols to numbers, during a given amount of time, according to a key. It is sensitive to changes in cognition in patients with multiple mental health and brain disorders.	[16]
	Multiple Object Tracking (MOT)	Measures selective/distributed and sustained visual attention.	[17]
	Paced Auditory Serial Attention Test (PASAT)	Measures information processing and sustained and divided attention. Consist on a test of serial addition. It is often used to assesses the effects of traumatic brain injury or other neurodegenerative disorders on cognitive functioning.	[18]
	Ruff 2 and 7 Test (Letters)	Measures visual selective attention utilizing different distractor conditions.	[7]
	Stop-Signal Task	Measures response inhibition (ability to suppress unwanted or inappropriate actions)	[19]
	Stroop Color/Word or Interference	Measures the ability to inhibit cognitive interference between two stimulus mismatch between the name of a colour and the colour it is printed on (e.g. the word "pink" coloured in blue. When asking what is the colour of the word it takes longer and people make more mistakes).	[8]
	Trail Making Test (TMT)	Measures visual attention and task switching (search and processing speed, mental flexibility and executive functioning).	[9]
Intelligence	Stanford–Binet Intelligence Scales	Measures cognitive strengths and weaknesses in children and adults: fluid reasoning, knowledge, quantitative reasoning, visual-spatial processing and working memory. Latest edition (SB5) also measures giftedness.	[20]
	Wechsler Adult Intelligence Scale (WAIS)	Measures multiple cognitive abilities and intelligence in adults.	[11]

Memory	ADAS Word List Recall	Alzheimer Disease Assessment Scale-cognitive subscale.	[21]
	Benton Visual Retention Test (BVRT)	Measures visual memory and perception and visoconstructive abilities.	[22]
	Rey Auditory Verbal Learning Test (RAVLT) (Delay, Temporal Order, Faces and Pictures)	Measures ability to encode, combine, store and recover verbal information.	[23]
	Ross Information Processing Assessment (RIPA) (Auditory Processing, Immediate Memory, Recent Memory)	Profiles 10 key areas in communicative and cognitive functioning: Immediate Memory, Recent Memory, Temporal Orientation (Recent Memory), Temporal Orientation (Remote Memory), Spatial Orientation, Orientation to Environment, Recall of General Information, Problem Solving and Abstract Reasoning, Organization, and Auditory Processing and Retention.	[6]
	Sternberg Memory Search Task	Series of tests aimed at determining how we access the information in our short-term memory.	[24]
	Verbal Learning and Memory Test (Delay recall, Direct Recall, Recognition)	Memory test that consist on five repeated auditory presentations of a word list. After each presentation the subject will try to recall as many as possible.	[25]
	Wechsler Memory Scale, IV (WMS-IV) (Facial Recognition, Immediate Figural Memory, Delayed Figural Memory, Immediate Logical Memory, Delayed Logical Memory, Verval Paired Associates, Visual Reproduction)	Series of tests that provided detailed assessments of clinically relevant aspects of memory functioning.	[26]

(continued)

Table 13.1 (continued)

	Scale name (sub-scales)	Consist in	S[a]
Working memory	Automated Working Memory Assessment	Measures active and passive memory (verbal and visuospatial) in children and adolescents.	[27]
	Corsi Block-Tapping Task (CBTT)	Measures visua-spatial working memory, similar to Digit Span Test.	[28]
	Digit Span Backwards	Measures transient number storage capacity.	
	N-Back Task (Auditory, Spatial)	Measures ability to remember whether a stimulus is similar to another presented previously (N trials ago).	[29]
	Self-Ordered Pointing Task (SOPT)	Measures working memory and the contribution of the frontal lobes to it.	[30]
	WAIS Digit Span Task (Letter Number)	Measures multiple cognitive abilities and intelligence in adults.	[16]
Academic Resilience	Academic Resilience Scale (ARS)	Measures the ability to succeed academically in the face of adversity.	[31]

[a] *S* Source

Visual Tools

Tools	Consist in	S
Executive function		
Approach/avoidance task (ATT)	Measures behavior when faced with a conflicting goal or event (which has both positive and negative characteristics or effects).	[33]
Working memory		
Automated Working Memory Assessment (AWMA)	Fully automated online assessment of working memory.	[34]
Functional capacity/Executive function		
Virtual Reality Functional Capacity Assessment Tool (VRFCAT)	Immersive virtual reality interactive gaming that measures functional abilities using realistic simulations of daily environments.	[35]

In this paper we focus on means of technology-enabled assessment and improvement of inclusive learning and quality of life in higher education.

Common Challenges to Inclusive Learning in Higher Education

Student's ability to learn and fulfil their educational goals is affected by different, physical, mental (as defined by DSM-5 [36]) and situational challenges. It is estimated that on the UK, 3.5% of full time university students had a mental health condition in the 2017–2018 academic year. We will now discuss how each one of them impacts learning.

Physical Health and Illnesses

During their university studies a student might have periods of ill physical health or hospitalization. While in most cases the physical illness has a short duration (e.g., flu), some students might have long periods of illness (e.g., broken arm) or might live with chronic conditions (e.g., Chronic Fatigue Syndrome). In those cases, the student might not be able to attend university for periods of time. As a result, they won't be able to take part in lectures, practical sessions or exams. They can also not engage with in-class activities, such as peer-assessment or debates. Additionally, students will struggle to submit paper-based coursework (although they may be able to submit coursework online). Moreover, if they are in pain (e.g., broken leg) the pain and/or pain medication might interfere with their concentration and sleep patterns. Finally, the injury or illness might prevent students from typing or taking notes.

Mental Health and Illnesses

While it is normal to feel sad or anxious at times, clinical depression and anxiety disorders can be crippling conditions, which can render the student unable to engage with their studies. Recent data shows that the mental health of students in higher education is deteriorating [37]. For example, a recent study from the Institute for Public Policy Research, reports that the number of first year students reporting a mental health problem in 2016 was 3 times higher than 10 years earlier in the UK [38]. As a result, there has been an increase in demand of Counselling and Mental Health services putting huge pressure on the universities' and local welfare resources. In order to deal with this challenge, universities, governments and charities are trying to increase their mental health provision and there is a rising number of preventive campaigns. Additionally, there is an increase interest in initiatives, which aim to embed mental wellbeing within the curriculum [39]. These initiatives can be very varied, encompassing, from university-wide curriculum infusion, such as the Engelhard project at Georgetown University, USA [40] to focus on processes that might cause undue stress or disadvantage to some students (e.g. the use of lecture capture to revise lectures they were not well enough to attend or the use of anonymous online interactive tools to eliminate social anxiety).

The most common mental health disorders experienced by undergraduate students are depressive disorders (e.g. major depressive disorder, bipolar disorder or seasonal affective disorder), and anxiety disorders (e.g. general anxiety disorder or social anxiety disorder) [41]. A small percentage of university-age individuals experience other types of mental health disorders such as schizophrenia [41].

Depression is a common mood disorder that is characterized by constant sadness, lack of hope, motivation and energy, disturbed sleep patterns, and difficulties to make decisions [36]. As a result students feel that doing every day tasks is a constant struggle; they feel worthless and believe that their actions are useless and so their engagement with their studies suffers (they may stop attending lectures or might not be able to keep up with coursework or revision). At times they can become angry because they feel judged by others and themselves and believe they are falling short of expectations all the time. Their view of the world is pessimistic and they believe their situation will never improve. In extreme cases the student might plan and/or attempt to take their own life, although the percentage is lower compared to the general population of similar ages [42].

Bipolar disorder is characterized by periods when the student is depressed (see above for symptoms) alternated with "manic" phases, when the student is overexcited and overactive, but often doing tasks that are not productive nor make sense (e.g., writing for hours an essay about how to tickle ants when the assignment was on the habitat of insects that live in colonies) [36].

Seasonal Affective Disorder is very similar to depression, but usually only happens during a time of the year (e.g. in the European context, commonly during winter, when the days are short and often there is lack of sun) [36, 43]. Often students find particularly difficult to wake up on time in the morning, and have low energy levels during the day. As a result students might stop attending lectures and/or struggle to keep up with studies.

Generalised anxiety disorder is characterised by constant worry which leads to difficulties in concentration and/or sleep. In extreme cases students might develop panic attacks (for example in an exam) [36].

Students suffering from **social anxiety** worry disproportionately about social activities, such as going to class or speaking in public [36]. They feel judged at all times by others and fear that they will do something in public that is inappropriate. They are scared of criticism and can become paralised when others are watching what they are doing (such as giving a public presentation). In extreme cases students might develop social phobia, where they avoid interacting with others or speaking in public and/or experience panic attacks.

Schizophrenia is a severe mental disorder characterised by relapsing episodes of hallucinations (hearing or seeing things that do not exist outside their mind), disordered thinking, social withdrawal and cognitive impairment [36]. Students with schizophrenia may react in "odd ways", sometimes believing that staff and/or other students are being bullies.

Learning Differences, Neurodiversity

Students' intellectual ability can vary widely resulting in some cases in being diagnosed with a learning difference/disability (neurodiversity). Specific learning disorder is defined by DSM 5 as "*a neurodevelopmental disorder with a biological origin that is the basis for abnormalities at a cognitive level*" [36]. One essential feature of specific learning disorder is persistent difficulties learning keystone academic skills. In the 2015–2016 academic year, the Higher Education Statistics Agency reported 4.95% of all students in the UK enrolled in all higher education had a Specific Learning Difficulty [44]. These disorders are often diagnosed in childhood and are managed with the help of school teachers/advisers and/or specialised software/techniques. However, when students reach university, they might struggle with the transition into a less structured and/or supportive environment. University students with learning differences can use specialized assertive and adaptive technologies, which compensate for the decreased ability (such as Texthelp[1] or ClaroView[2] and ScreenRuler,[3] which can help them reach their full academic potential [45]. There is a spectrum of learning differences as discussed below.

Students in the **Autism spectrum or Aspergers** find it hard to figure out what others are thinking or feeling based on their facial expressions and/or words [36]. Because of this they find socialising difficult. Noise or crowded spaces might be overwhelming for somebody with autism and thus sometimes they need to retire to a quiet space in order to calm down (they may also sit close to the entrance in class

[1] https://www.texthelp.com/

[2] https://www.clarosoftware.com/

[3] https://www.clarosoftware.com/

so that they can leave easily or might avoid crowded/noisy classrooms). They can seem awkward or feel uncomfortable in social situations, not making eye contact (resulting in appearing rude or patronising). Often they may take literally what is told to them (so they might struggle to understand jokes or sarcasm). Additionally, changes in their routine can cause them anxiety. Because of this they are very keen on having clear plans for everything that has to happen.

Students with **dyslexia** often mix up letters that have some similarity (like "b" and "d") or words that have very similar spelling (e.g. "from" and "form"). As a result they often make spelling mistakes and are very slow readers/writers. They avoid reading and/or writing whenever they can (e.g. they will prefer a presentation than a written exam or coursework). They also struggle to write coherent notes during lectures (as they struggle to write while trying to understand what the lecturer is explaining and reading from the slides). However students with dyslexia can easily understand information when it is spoken to them and can explain themselves orally much clearer than in writing. Sometimes they struggle to follow directions (sequence of things that have to be done in a certain order) and thus find it difficult to organise and plan, which compound with their writing challenge results in students struggling to meet coursework deadlines [46].

Although **Attention Deficit Hyperactivity Disorder (ADHD)** is not considered a learning disability, it has at times a profound impact on the ability of the student to learn [36]. ADHD is characterised by difficulties in focusing (and lack of attention to details) and hyperactivity (which might make attending to long lecturers, of finishing coursework a challenge). At times, a student with ADHD might have difficulties coping with stress or remembering.

We should note that learning disabilities often do not sit in binary silos where the student either has a learning disability or not (with students often displaying different grades of a learning disability) [36]. Therefore, scholars are starting to strongly argue against the concept of "the average or typical student". They reason that the students traditionally identified as having learning differences belong to the extremes of a continuum [47] and that we could consider that all students abilities are scattered across a spectrum of learning differences [48].

Students Juggling Higher Education with Work or Caring/Family Commitments

The majority of university students are relatively young (between late teens to mid 20s), do not have caring responsibilities (such as caring for young children or elder relatives) and do not need to work in order to fund their studies and daily life [49]. However, due to recent economic downturns and drastic increase in university fees, many students in higher education have to work while they study, in order to provide for themselves and/or finance their studies [50]. Moreover, due to an increased diversity in student population and the development of graduate entry courses, there is a slight rise in the number of university students with family and/or caring commitments, particularly within some vocational disciplines such as nursing [51].

These commitments might at times clash with their studies, preventing them from attending university (as they have to work or take care of somebody). Thus, at times, they may not be able attend lectures, practicals or exams. They might also struggle to submit paper-based assessments and can not benefit from taking part in in-class activities.

Method

In view of answering our research questions 2 and 4, we relied upon a mixed methods research approach based on literature reviews, surveys and interviews as shown in Fig. 13.1.

To get an accurate understanding of the problem definition, the research started with (a) reviewing the most common learning challenges using the Diagnostic and Statistical Manual of Mental Disorders (DSM–5) as primary source and selected literature as secondary source (presented in the previous section). We then built upon a (b) recent literature review [52] to gain a deeper understanding on the role of information technology (IT) in education as well as a description of digital learning platforms and the evolution of learning management systems (LMS). (c) We then surveyed eight faculty members (see table below) to gather current uses of digital learning platforms (Table 13.2). We asked them the three following open-ended questions: (q_1) "What digital platforms or tools do you use for your lectures?" (q_2) "What makes these platforms or tools attractive?" and (q_3) "What other platforms would you recommend and why?" (d) By means of interviews, we then asked the same questions to one course director and three learning designers to gather their experiences of state-of-the-art tools for inclusive learning. The interviews allowed us to derive four digital learning tools categories, categorized independently by the co-authors of this paper. (e) In order to analyze the commonalities and differences across these four categories, we used the Business-Application-Information-Technology (BAIT) model. We then summarized our findings by refining the seven principles of the Universal Instructional Design [53, 54] framework for the context of inclusive learning.

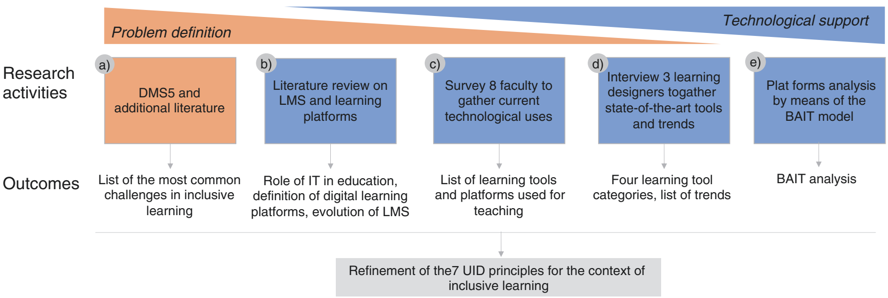

Fig. 13.1 Research methods

Table 13.2 Profiles of survey participants in step (c) and (d)

Academic position	Country	Current class size	Educational area
Associate professor, 2 years of TE[a]	United Arab Emirates	40–65 BSc students	Medicine
Assistant professor, 4 years of TE	United Arab Emirates	25–65 BSc students	Medicine
Professor and chair, 20 years of TE	Switzerland	30–200 BSc and MSc students	Business informatics
Assistant professor, 5 years of TE	Switzerland	30–70 BSc and MSc students	Business informatics
Professor, 12 years of TE	Switzerland	50–300 BSc and MSc students	Economics
Teaching Fellow, 2 years of TE	United Kingdom	100–300 BSc and MSc students	Life Science
Associate Professor, 6 years of TE	United Kingdom	20–200 BSc and MSc students	Life Science
Assistant Professor, 14 years of TE	United Kingdom	15–200 BSc and MSc students	Life Science
Course director, 7 years of TE (+15 years in secondary school teaching)	United Kingdom	45 Foundation year students	Life Science
Senior learning designer, 8 years of TE	United Arab Emirates	300 BSc and MSc students	Health Sciences
Senior learning designer, 6 years of TE	United Arab Emirates	250 BSc and MSc students	Health Sciences
Learning designer, 4 years of TE	United Arab Emirates	250 BSc and MSc students	Health Sciences

[a] *TE* Teaching Experience

Digital Learning and Teaching Platforms (DLTP) Description and Analysis

Along with the almost universal access to personal computers and smartphones, Internet and web applications have disrupted education [52]. Not only have they changed the way knowledge is transferred and learnt, but also the dynamics between lecturers and students as well as among the students. From our interviews with learning designers (Table 13.2), four categories of digital learning and teaching platforms have emerged, as potential enablers for the assessment and improvement of inclusive learning: Learning Management Systems (LMS), Social and collaborative tools, In-class interactions and Out-of-class interactions.

Learning Management Systems

LMS are software applications designed with the specific intent of assisting instructors in meeting their pedagogical goals of delivering learning content to students [55]. Available as web application by means of an Internet browser (Figs. 13.2 and

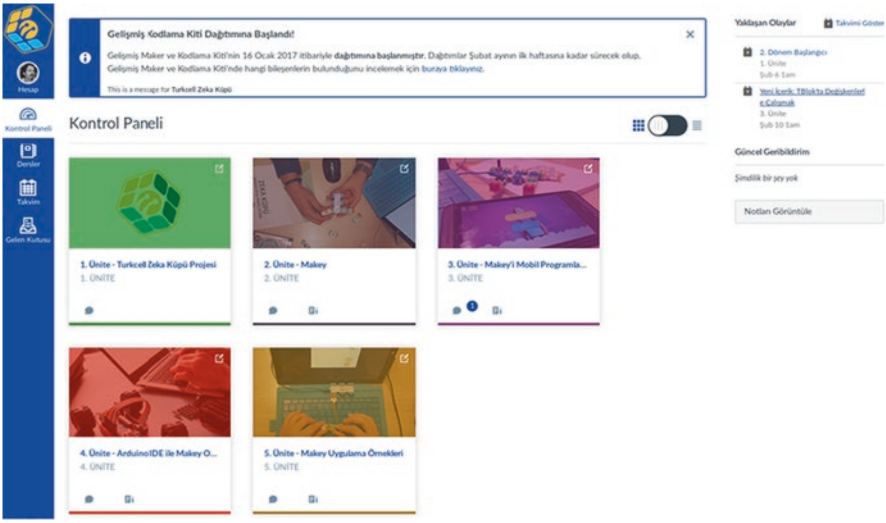

Fig. 13.2 Canvas LMS—Assignments View of a Class (Under the license: https://creativecommons.org/licenses/by-sa/3.0/deed.en)

13.3), LMS have disrupted the way students access (digital) lectures, communicate with their lecturers, classmates and other learning communities, access course materials, take online quizzes and submit their assignments [56]. From the lecturer's point of view, LMS allow to organize classes, publish course materials, create and grade assignments among many additional features. Our interviews revealed two types of software applications: Open-source with Moodle[4] being on top of the list and Graasp[5] in the role of outsider [57]. On the proprietary side, Canvas[6] was the most cited. In our case, LMS were used to structure and describe lectures, upload and share documents, lecture recordings and tutorials as well as post and submit assignments. Uploaded files are presentation slides, PDF and text documents. Our survey revealed that LMS are mostly accessed via desktop or laptop computers.

Social and Collaborative Tools

Social and collaborative tools are defined as (web-based) applications that allow users to create and to share online documents, spreadsheets, presentations, and forms [58]. They are mostly used by students to create and share content such as assignments. Similar to LMS, open-source and proprietary tools are being used. The

[4] https://moodle.com
[5] https://graasp.eu
[6] https://www.instructure.com/canvas/

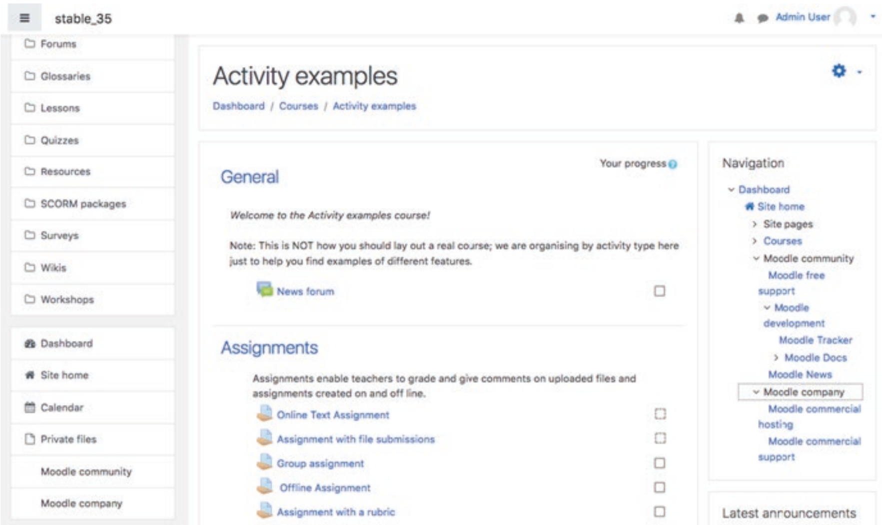

Fig. 13.3 Moodle—Class View

two most used are respectively Google Docs[7] and Microsoft Office 365.[8] They allow students to create different types of documents from presentations to spreadsheets and letters and work simultaneously on the same documents (Fig. 13.4). As part of Microsoft Office 365, Teams offers new opportunities for lecturers to engage with students, and also for creating groups amongst students. It provides instant messaging capabilities, both via text and video, enabling lecturers and students to communicate regardless of their location. In addition, it offers live captions to help students with hearing impairments. Newcomers such as Padlet[9] are increasingly used in class for students to publish their work and collect feedback (Fig. 13.5). These tools are most of the time accessed from a desktop or laptop computer while a mobile interface is also available but difficult to use.

In-Class Engagement

As stated in Holzer et al. 2013 [57], interactivity in person classrooms is considered an important success factor in learning but it remains very challenging to promote. Simple technologies such as the *Clickers* (that combine hardware with software) gained popularity in classrooms for their ability to gather anonymous answers to questions asked in class [59]. It gives the lecturer a chance to immediately assess the

[7] https://docs.google.com
[8] https://www.office.com/
[9] https://padlet.com

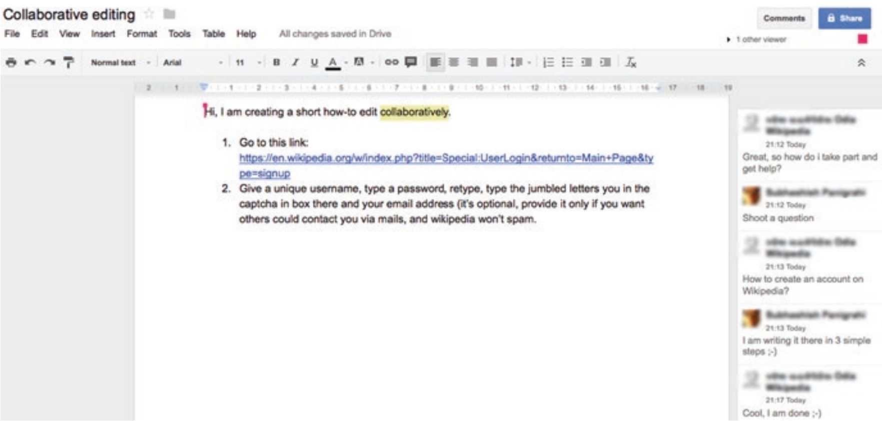

Fig. 13.4 Padlet—Main View (shared amongst groups or students)

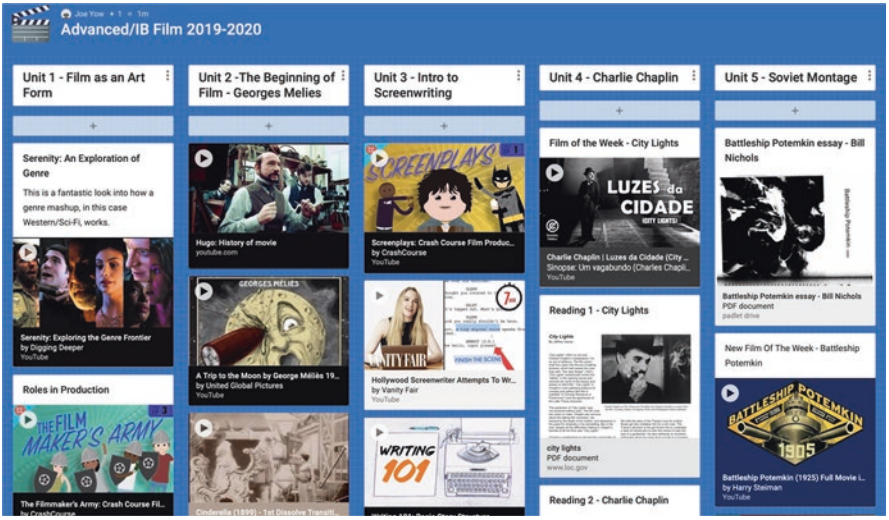

Fig. 13.5 Google Doc—Collaborative work (Under the license: https://creativecommons.org/licenses/by-sa/3.0/deed.en)

students' knowledge and quantitatively measure the progress of the class (Fig. 13.6). The in-class engagement tools are seen as the next generation of interactions by allowing lecturers and students to send anonymous text messages in addition to creating polls (Fig. 13.7). They are mostly used by lecturers to gather feedback from students and to encourage them to engage in lectures/workshops/seminars. A few tools were revealed by the survey: Speakup,[10] which was developed by two Swiss

[10] http://speakup.info

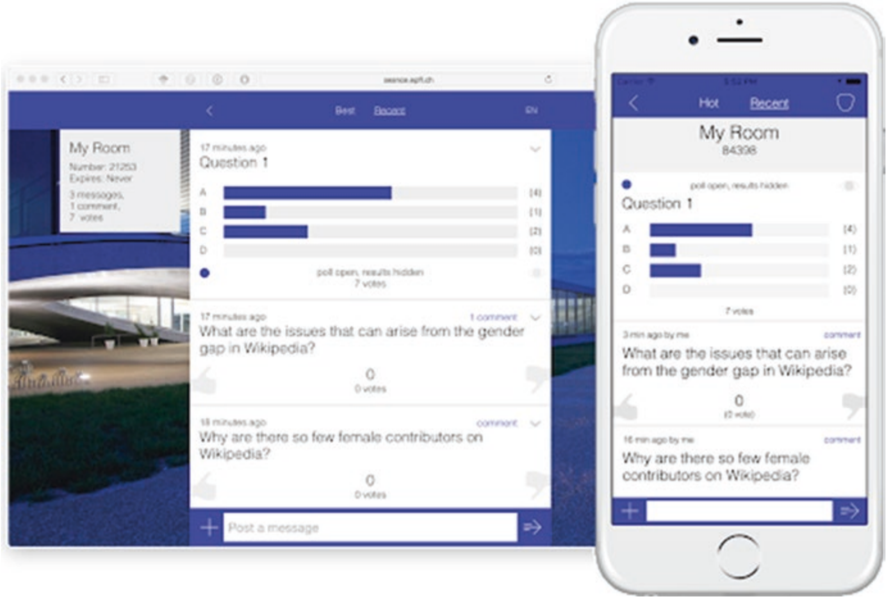

Fig. 13.6 Mentimeter—Live question/answers

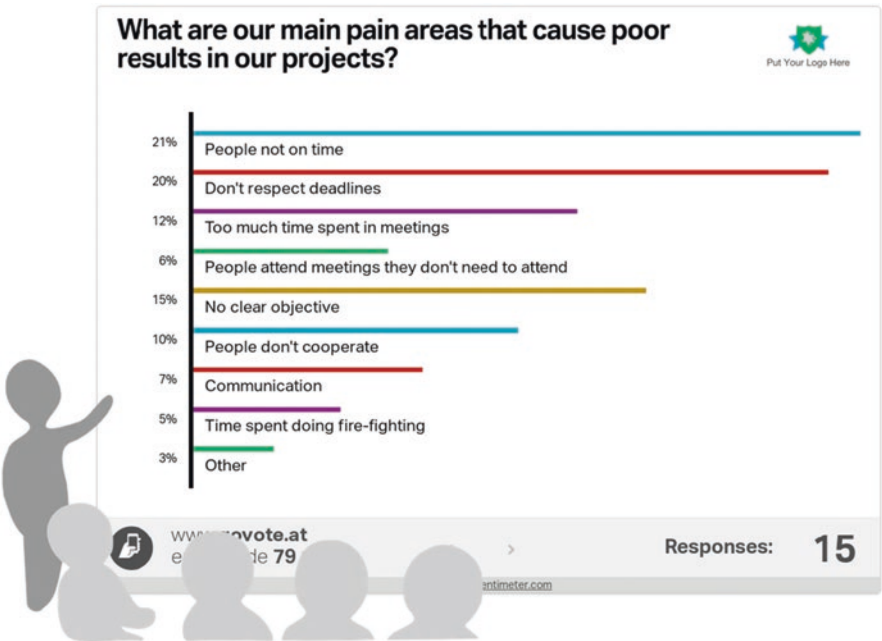

Fig. 13.7 SpeakUp—Live question/answers

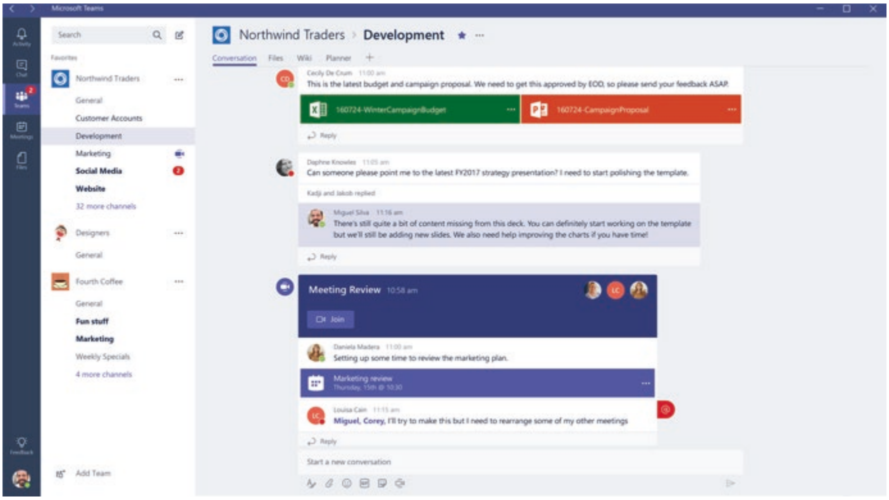

Fig. 13.8 Ms. Teams—Discussion panel

universities and available free of charge; Socrative[11] and Slido[12] that offer similar functionalities than Speakup; Mentimeter[13] that also allows for the creation of pools but requires a subscription for intensive usage; and Kahoot[14] that leverages the concept of gamification. All these tools are available as web and mobile applications and are most commonly used from a smartphone and laptops.

Out-of-Class Interactions

Out-of-class communication channels widely depend upon the university, the faculty/school (discipline) and the culture. Most of the course communication and feedback relies on emails or on LMS (e.g., class forums). Tools such as MS Teams,[15] Speakup or Slido are also used after the class whereby lecturers or students give feedback (Fig. 13.8). Recently Whatsapp[16] and other text message applications have become very popular amongst students to exchange tips and documents. These latter tools are easier to access and to use, thanks to their integration in smartphones.

[11] https://www.socrative.com
[12] https://www.sli.do
[13] https://www.mentimeter.com
[14] https://kahoot.com
[15] https://www.microsoft.com/en-ww/microsoft-365/microsoft-teams/group-chat-software
[16] https://www.whatsapp.com

Table 13.3 Platforms listed by the surveyed faculty

	LMS	Social and collaborative tools	In-class engagement	Out-of-class interactions
Teaching processes	Manage classes, documents and assignments	Create and share content	Assess knowledge and understanding	Share or ask course information
Application	Moodle, Canvas, Graasp	Office 365, Google Docs, Padlet	Speakup, mentimeter, Kahoot, Socrative, Slido	LMS, whatsapp, emails
Information	Lectures, readings, tutorials, assignment (description)	Assignments (content)	Course-related questions and answers	Course-related catch up information
Files	PDF, PPT, videos, images	DOC, PPT, PDF	N/A	(text messages) photos, videos
Technologies	Web applications	Web applications	Web applications, mobile applications	Web applications, mobile applications
Mediums	Desktop and laptop computers	Desktop and laptop computers, tablets	Desktop and laptop computers, smartphones	Smartphones (desktop and laptop computers)

Within and Cross DLPT Analysis

Table 13.3 summarizes and analyzes the differences and commonalities of the identified DLTP. As analysis framework, we used the Business-Application-Information-Technology—BAIT model [60]. The latter is used to logically and functionally describe a system and its dependencies. More specifically, the Business layer looks at the business rationale and the processes that follow from it; the Application layer investigates the organization of capabilities and functions; the Information layer looks at the data models; and the Technology layer investigates the implementation of logic, standards, bundling and tooling. For a more distinct analysis across the DLTP, we adapted the BAIT model as follows: The Business layer became the teaching process. We added a File layer to represent the types of file managed by the system and a Medium layer to be able to better differentiate the medium used to execute the application.

Assessment and Improvement of Inclusive Learning with Digital Learning Platforms (DLTP)

The analysis above sheds light on the types of application used by a selected sample of lecturers. Though it helps identify what applications and functionalities are the most popular DLTPs, the following critical question remains: How much do these learning platforms and applications support inclusive learning, and how it can be evaluated based on the data originating from these platforms? To answer it, we proceeded as follows: First, we extracted the challenges linked to inclusive learning as described in the section above. Second, we classified the challenges along three impairments—i.e., physical that refers to a student's physical limitation to follow a course; cognitive that refers to a student's potential troubles to remember, learn new things, concentrate, or take decisions and behavioral that refers to inability for a student to build or maintain satisfactory interpersonal relationships with his or her classmates and lecturers (Table 13.4). Third, we mapped these impairments to functionalities provided by digital learning platforms and tools and reasoned upon their assessment functionalities based on the data originating from the application logs (Table 13.5). Finally, we suggested potential implications and functionalities for some of the unmet challenges based on our focus groups with learning designers (N = 3).

Physical Impairments

Physical impairments are divided into two subcategories: (a) The inability to attend classes or exams, caused by injuries, care commitments or illness, and (b) some limitations that prevent students to hear, type or see. For the former (a), DLTPs should allow students to access teaching materials regardless of their location, as long as they have an Internet access. The policy with regards to video-recording of the lectures depends very much upon the university. In some cases, all classes are recorded, while the opposite is also true. Traditional universities are afraid that students would not attend classes if they had online access to such content. Given that some students might not return to classes for several months, the ability to view lectures and write exams remotely is critical. Software applications such as Examsoft[17] or Rogo[18] that provide an Internet-based safe environment are increasingly used by universities (particularly during the Covid pandemic). On the other hand, students suffering from hearing, typing or visual impairments (b) are not offered much help from DLTPs. Though collaborative tools such as Office 365 embed "read aloud" and "dictate" functionalities for Word and Excel, it is often not the case for slide-decks (e.g., PowerPoint) that require the lecturers to manually add captions. Similar problems can occur with PDFs documents depending on the original format and the conversion process. Moreover, video captions are also very rarely added by lecturers and when added the caption software can make mistakes (particularly when scientific terms and acronyms are used). However, some applications such as Microsoft Teams allow for live captions. Lastly, students who have difficulties using a keyboard do not receive much support from DLTPs. Although there

[17] https://examsoft.com

[18] https://getrogo.com

Table 13.4 Inclusive learning conditions and system requirements

Inclusive learning conditions		System requirements	R#
Behavioral	Difficulties coping with stress and anxiety	Assessment of stress, anxiety level and exercises such as meditation which might complement medical treatment (e.g. medication or counselling)	1
	Become angry with others	Assessment of anger level and exercises to reduce it. Some might complement medical treatment (e.g. Cognitive Behavioral Therapy (CBT))	2
	Hallucinations	Assessment of the hallucination and treatment to reduce it might complement medical treatment (e.g. medication or CBT)	3
	React in "odds way"	Assessment of the behavior and whether it impairs learning and/or normal life. If it does develop	4
	Anxiety/Worry disproportionally	Assessment of the condition and suggestion of exercises according to the condition, which might complement medical treatment (e.g. anxiolytics or CBT)	5
	Depression	Assessment of the condition and suggestion of exercises according to the condition, which might complement medical treatment (e.g. antidepressants or CBT)	6
	Scared of criticism and feel judged/Perfectionism	Assessment of the condition and suggestion of exercises which will complement treatment (e.g. Counselling or CBT)	7
Physical	Not able to attend lectures	Distance learning capabilities	8
	Not able to attend exams	Distance exam taking and monitoring	9
	Not being able to hear	Generation of content captures (images, schemas, videos) and audio captures (lecturers, students)	10
	Not being able to see	Generation of content captures (text, images, schemas, videos)	11
	Not being able to type	Speech recognition throughout the different applications	12
Cognitive	Attention—Difficulties focusing	Assessment of the attention and exercises to improve focus and attention (some might complement treatment such as medication)	13
	Memory—Difficulties remembering	Assessment of the "memory" and exercises to improve memory	14
	Executive function—Mix up letters	Assessment of the condition (e.g., dyslexia) and exercises to improve and use of specialized software or hardware (e.g. colored filters)	15
	Executive function—Slow readers and writers	Assessment of the impairment (might be one of the symptoms of dyslexia). Alternative input and output modes (e.g., voice) and exercises to improve or use of software to read text and to type text	16
	Executive function—difficulties to follow and organize plans	Assessment of the condition (e.g., dyslexia) and exercises to improve and specialized software (e.g. mindmaps)	17

Table 13.5 Map between system requirements and DLTPs

R#	LMS	Social and collaborative tools	In-class engagement	Out-of-class interaction	Opportunities
1	Asynchronous teaching (e.g. video recording of lectures, so that student can stop/rewind when needed and does do not stress them because they might not understand a detail)	Offline interactions (reduce stress of in-preson interactions)	Software to ask or answer questions anonymously	Use of online tools to interact that do not require in person meeting	Wearables such as Apple Watch[a] or FitBit Sense[b] embed mechanism to detect stress using different biomarkers. There also exists dedicated mobile apps, building on scientific research, to assess and reduce stress [61]. More commercial solutions are also on the market such as Headspace[c]
2	Asynchronous teaching (e.g. video recording of lectures, so that student does not need to come in person to a room where they might become angry with others)				Some scientifically tested mobile applications allow the assessment and management of anger, notably based on Remote Exercises for Learning Anger and Excitation (RELAX) [62].
3	Asynchronous teaching (e.g. video recording of lectures, enable student to study the material when medication has helped reduce the psychosis)				Several mobile apps allow for the assessment and treatment of hallucinations [63].

(continued)

Table 13.5 (continued)

R#	LMS	Social and collaborative tools	In-class engagement	Out-of-class interaction	Opportunities
4,5	Asynchronous teaching (e.g. video recording of lectures, so that student does not need to attend in person, reducing chances to interrupt the study of other students because of their odd behaviour)	Offline interactions (reduce disruption cause by odd behaviour, e.g. tourette syndrome)	Software to ask and answer questions online will enable student to participate regardless of ticks or other odd behaviour	Use of online tools to interact that do not require in person meeting (e.g. small group meetings using MS Teams where cameras are off so student does not have to worry about suppressing ticks or other odd behaviour)	
6			Software to ask or answer questions anonymously		
7					There exist many mobile apps that help assess the condition and suggest digital therapies [64].
7		Distance learning is enabled by means of slide sharing and live sessions.	Students and teachers can interact via video or text messages.		
8,9	Additional modules allow for protected and secured online exams			Bespoke apps/ webpages for online examination (e.g. Rogo)	
10		Voice captures can be automatically generated (from video too), while image captures require manual description.		Text messaging software/tools enable off class interaction with peers	

Table 13.5 (continued)

R#	LMS	Social and collaborative tools	In-class engagement	Out-of-class interaction	Opportunities
11		Platforms such as Office365 embed "read aloud" throughout its applications. Still limited with pictures or other media.			
12					Specialized dictation software[d]
13	Class material (including videos) can be accessed away from the classroom (in a quiet place with less distractions) and at a time when the student is less tired				Mobile apps,[e] scientifically tested can help student focus
14	Class material (including videos) can be accessed multiple times to enable revising multiple times content				Mindmap software to organize the knowledge more visually[f]
					Several apps have shown to be efficient to assess, improve information retention and exercise the memory [65, 66].
15		Software (like Office365) help with spelling and grammar			Apps can support the assessment and provide exercises to improve the condition [67].

(continued)

Table 13.5 (continued)

R#	LMS	Social and collaborative tools	In-class engagement	Out-of-class interaction	Opportunities
16		Platforms such as Office365 embed "read aloud" throughout its applications			Specialized dictation software[g] Content captures as well as speech recognition apps can help with providing alternative modes.
					Specific apps can also be used to work on different aspect of the memory and help develop reading and writing skills [68].
17	Timetables embedded in LMS can help student create their individual timetable	Platforms such as Ms. Teams embed calendar functionality that can be linked to online classes			Time management tools such Rescue Time[h]

[a]https://www.apple.com/ae/watch/
[b]https://www.fitbit.com/global/us/products/smarwatches/sense?sku=512BKBK
[c]https://www.headspace.com/
[d]https://www.nuance.com/en-gb/dragon.html
[e]https://www.frontiersin.org/articles/10.3389/fnbeh.2019.00002/full
[f]http://freemind.sourceforge.net/wiki/index.php/Main_Page
[g]https://www.nuance.com/en-gb/dragon.html
[h]https://www.lifehack.org/articles/technology/top-15-time-management-apps-and-tools.html

exist additional software applications such as DragonSystems,[19] they would only partially fulfill the tasks of a student. As an alternative, in-class engagement apps can also be used post-lecture to continue discussions that occurred during lectures. To conclude, multimodal access to content is currently missing.

Cognitive Impairments

Cognitive impairments refer to students who have difficulties focusing, remembering and those who are slow readers and mix up letters. It can also be side effects from anxiety, stress, depression or medication taken for physical or mental health

[19] https://www.nuance.com/dragon.html

disorders such as pain or schizophrenia. In both cases, online access to teaching materials and video-recordings in particular, brings many advantages. Students can learn at their own pace, moving back and forth until they have acquired the knowledge. However, LMS and other platforms fail at two levels: (a) in providing tailored learning experience, assuming that each student has the same learning capacity, (b) in assessing the condition and providing exercises to support the students. Similar to guidelines for people suffering from physical impairments (e.g., minimum font-size, reduced amount of length, prioritizing images), digital learning platforms have the opportunities to implement machine learning driven quizzes that adapt the questions to the learners as well as adapt the content presentation (e.g., learning section) too. In parallel, students can also use wearables to track their biometrics and thus have a more objective assessment of the impairments.

Behavioral Impairments

Students with disorders such as depression, anxiety, autism or schizophrenia display some behavioral impairments that prevent them from fully engaging with the learning. They sometimes have access to support workers that take notes for them or extra time during assignments. They also sometimes have access to "safe" environments such as dedicated rooms for them to calm down in case of a sensory overload. Aside from this, tools such as Speakup offer safe digital space in which students can anonymously ask and answer questions without the fear of being individually criticized or judged. For students whose behavioral impairments prevent them from attending lectures or can attend only partially, remote access to teaching materials (e.g., video-recordings or slides) significantly increases the students' chance to succeed. In this view LMS plays an important role as central platform for content access but also for handing in assessments and receiving potential feedback and discussions such as in forums.

What Do DLTPs Support? What Remains Unsupported?

In order to analyze the means by which DLTPs address the identified inclusive learning conditions summarized in Table 13.4, we extracted the system requirements from the same table and mapped them to functionalities provided by the currently used, digital learning platforms and tools. We added a column *opportunities* to demonstrate how technologies beyond our scope of analysis can support inclusive learning. The results are presented in Table 13.5. The first column of the table, R#, refers to the system requirements presented in Table 13.4. We also differentiate between technologies that assess or directly address the condition (in dark grey) and those that mitigate (in light grey) the condition. For instance, condition R#—difficulties coping with stress and anxiety: DLTPs offer functionalities to mitigate the condition by means of asynchronous teaching that allows students to review the

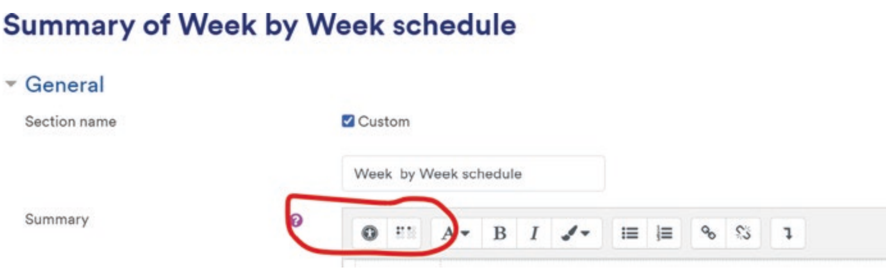

Fig. 13.9 "Accessibility checker" and "screen reader helper" currently embedded within the LSM system Moodle

knowledge as many times as required, and offline and anonymous communication that allow students to be protected. On the other hand, wearables and mobile apps relying on biometrics and self-reporting allow for a quantitative assessment of the level of stress.

When looking at the table above, it is clear that the coverage of inclusive learning's needs by the identified DLTPs is very limited. Most of the platforms rather mitigate (dark grey) than assess and improve the different conditions. Apart from providing distance learning capabilities required for students who cannot access the facilities, the tools fail in supporting behavioral and cognitive impairments. Let us take stress problem as an example: though some of the learning designers we interviewed have setup dedicated pages and modules in LMS to provide links to specialized websites, DLTPs do not support students in assessing and helping with their stress overload. However, while a considerable number of techniques, approaches and a significant number of mobile applications a at the moment, DLTPs do not provide any integration for these applications. For some of the challenges for learning, we identified specialized tools/apps that are already on the market. However sometimes it might be challenging to embed them within the existing learning technologies. Some of the current technologies are starting to address this issue (i.e. Moodle "accessibility checker" and "screen reader helper" as shown below (Fig. 13.9).

Additionally, in some cases the challenges faced by students require medical intervention (e.g. psychosis or depression). In these cases the teaching apps should facilitate learning, but they can not replace medication and/or talking therapies. For the majority of the conditions, assessment capabilities are available with external applications (light grey). Very often these applications and platforms have been scientifically evaluated.

Supporting Inclusive Learning: Implications for Design of Future Platforms

Increasing access to learning has been the focus of a great deal of research. The Universal Instructional Design (UID) is certainly the most comprehensive [69]. It builds on the concept of Universal Design to identify and eliminate unnecessary barriers to teaching and learning while maintaining academic rigor. UID is therefore described as a process that involves considering the potential needs of all learners when designing and delivering instruction. We used the UID as framework in order to refine the seven UID principles for the purpose of inclusive learning. Our inclusive learning principles, presented in Table 13.6, build upon the analysis that we presented above as well as the survey and the interviews we conducted.

Table 13.6 Universal Instructional Design applied to inclusive learning

UID principles	Application in the context of inclusive learning
Accessible and fair (equitable) use: Instructions should be designed to be useful and accessible by people with different abilities, respectful of diversity, and with high expectations for all students.	Universities and lecturers should make use of video-recordings as well as remote access to teaching materials for students who cannot physically attend classes. In addition, they should use (automatic and accurate) captions as much as possible to reach students suffering from hearing impairments.
Flexibility in use, participation and presentation: Learning is most effective when it is multimodal. Instruction is designed to meet the needs of a broad range of learner preferences. Students can interact regularly with the instructor and their peers.	Content should be delivered in different ways including videos (with audio) and in writing. Lecturers should also use digital forums and other in-class engagement tools to foster exchanges with and among students.
Straightforward and consistent: Instruction is designed in a clear and straightforward manner, consistent with user expectations. Tools are intuitive. Unnecessary complexity or distractions that may detract from the learning material or tasks are reduced or eliminated.	Content (e.g., terminologies, description, abbreviations, file names) as well as learning objectives should be presented consistently across all digital platforms used by the lecturers. If applicable, a dictionary of terms shall be accessible. Humor or references to undocumented content should not be used.
Information is explicitly presented and readily perceived: Course expectations are transparent. Instructions are easy to understand. Communication is clear. Any barriers to receiving or understanding are removed. Information may be presented in multiple forms.	One digital platform (e.g., LMS) should be used as a central hub to indicate the learners what to do and where to find the information. Lecturers must choose digital platforms and communication channels accessible by all students (e.g., cross platforms).
Supportive learning environment: Instruction anticipates that students will make mistakes. While instruction recognizes that errors are necessary, and if handled properly, present powerful learning opportunities. It tries to minimize hazards that can lead to irreversible errors and failures. Instruction also recognizes that systems will fail and things can go wrong—thus, a tolerance for error and preparation by way of backup are important so that learning will not be interrupted.	Instructions should be designed so to reduce the chance of mistakes to its minimum. It starts with the use of a widespread vocabulary accessible to everyone and continues with a session design that ensures that students identify potential misunderstandings rapidly. It includes the use of self-assessment tools, group work, in-class interactions and quizzes (which provide a safe environment for mistakes to be used as learning opportunities).

(continued)

Table 13.6 (continued)

UID principles	Application in the context of inclusive learning
Minimize or eliminate unnecessary physical effort or requirements: Instruction is designed to minimize non-essential physical effort (i.e., not related to a learning outcome) in order to allow maximum attention to learning.	Instruction and knowledge must be accessible for students regardless of their impairments. The lecturers should make use of remote access whenever possible. Vocabulary as well as instructions must be as clear as possible. Students should also be able to hand in assignments or exams online, while using a system that integrates word processing whenever appropriate.
Learning space accommodates both students and methods: The learning space is accessible and the environment supports multiple instruction strategies.	Learning spaces (e.g., method, content, discussion, assignment) should be physically and mentally accessible by all students. It should combine spaces for physical and virtual classes, communications and instructions. The learning space should adapt according to the individual student needs and impairments.

Discussion

There is no doubt that information technology is transforming education. When used for assessment and improvement of inclusive learning, it offers a wide range of opportunities for students suffering from behavioral, physical and cognitive impairments. Beyond the application's functionalities and goals, from our data and own observations, we identified five key elements for a successful implementation and uses of digital platforms and tools that assess and improve the individual's inclusive learning. The discussion part ends with some limitations and a note to the significant positive impact that information technology to enable teaching and learning during the Covid19 pandemic.

Assessment vs. mitigation of the conditions Apart from physical impairments that are not necessary expected to be assessed via DLTPs, behavioral and cognitive impairments are not assessed by DLTPs as shown in Table 13.4. They rather provide limited functionalities to mitigate the conditions such as "read aloud" for students suffering from visual impairments. Though logs from DLTPs can be used in order to assess the number of interactions between students and teaching material for instance, this functionality has its limits. It will not inform the lecturer whether the student has read or understood the lecture, but only that he had opened it. However, a huge number of opportunities come from mobile applications as well as wearables that rely on either biometrics or self-reporting to provide objective assessment of the conditions. This is notably the case for stress and anxiety, attention loss and memory retention's problems.

Usability Research has looked into the usability of digital learning platforms and learning management systems in particular. As stated by Harrati et al. (2016), "*Positive user experience is of prime importance for educational learning systems* *playing vital role for the acceptance, satisfaction and efficiency of academic institutions*" [70]. Usability of digital learning platforms has drawn the attention of many researchers after universities and schools complained that the tools do not bring the promised outcomes and that they are not used appropriately. For example, it is not uncommon for universities to install plugins for improving user interface's ease of use. For a successful implementation of digital learning platforms, it is then critical for the solution provider to focus on user-centeredness (e.g., lecturer, student). Though most LMS embed functionalities to interact in classes and create pools to engage with students, all lecturers that we interviewed use additional applications for their high usability and accessibility. It is even more important in the case of inclusive learning due to students' potential impairments.

Integration in the lecture design It is not sufficient to equip lecturers and students with digital learning platforms and tools. The latter must be fully integrated in the course and curriculum design. Video-recordings as well as in-class engagement activities must be part of a wider program aligned with learning objectives.

Integration in the enterprise architecture In-class engagement apps as well as collaborative tools are rarely integrated with learning management systems. Beyond technical challenges, they require taking additional steps (e.g., different logins, user interfaces, terminologies) that become confusing for students with cognitive impairments. Universities therefore have to ensure that the same terminologies and descriptions are used. As mentioned above, one system (e.g., LMS) must play the role of central hub from which students can access every other application.

Platform monitoring Once in place, the adoption and usability of the platforms have to be closely monitored, also serving for an assessment of the inclusive learning path, i.e., the learning path of the individual. For each impairment category, champions amongst students have to be identified and their uses (e.g., logs) analyzed. Together with the lecturers, learning designers and software providers, universities have to collaborate to ensure that the functionalities meet the student needs. Although it might sound trivial, it is much often not the case as highlighted by the learning designers we interviewed.

Assessment and impact on quality of life In their current implementations, digital learning platforms are designed to assist rather than assess students' quality of life. Following the Quality of Life Technologies' definition [71], DLPT are limited in two areas. First, in quantitatively assessing and informing the students with regards to their improvement in any of the three impairments: physical, behavioral and cognitive. To date, only the total (sum up) mark for all assessments in a subject/course/module can be used to assess any type of progression. Though time spent on lectures, number of submission's attempts, number of typos could potentially be used to evaluate a student's progress, this information is not available to students nor educators. Second, in integrating data from sensors, activity trackers and mobile devices, students (and potentially parents) and teachers have a chance to either detect or follow up on some conditions and quality of life in particular using quantitative data [72]. In addition to questionnaires that are given to students at the beginning of the semester to assess e.g., stress and anxiety, the integration of continuous data from sensors in the LMS could help students, parents and schools to quantitatively analyze students' progress and more importantly find correlation between changes in quality of life and impact of academic results.

Digital therapeutics Some behavioral conditions such as stress, anxiety and depression, digital therapeutics are seen as a new type of (mobile) applications that are either used to complement medication or to replace it. Described as "*evidence-based therapeutic interventions driven by high-quality software programs to prevent, manage, or treat a medical disorder or disease*[20]", some of these applications have already been approved by the U.S. Food and Drug Administration. Building on Cognitive Behavioral Therapy, these applications engage with their users on a daily basis while using objective data to assess and customize digital treatments [73]. These applications could be seen as an alternative or a complement to counselling sessions.

Overcoming learning ability? Limitations Technology, and in particular the apps/programs discussed this chapter, is not the only solution to facilitate inclusive learning. Often students benefit from a combination of multiple high-tech and low-tech approaches, tailored to their unique needs. For example, there is software specially developed to help students with learning difficulties (such as Optical Character Recognition software to help students with dyslexia or talking calculators to help students with dyscalculia), which has been widely reviewed on [45, 74]. Another example is granting extension on coursework deadlines to enable students with dyslexia the extra time they may need for proof reading or to provide a student with a broken arm time for their arm to heal, so that they can write the coursework. Additionally, students with mental health disorders (poor mental health) often require medical treatment aimed to heal their condition, such as medication and/or counselling, which has little to do with the platform capabilities. Another word of caution included a comment that "*There are many other apps, but they tend to behave similarly to the ones we analyzed*" (comments from a learning designer), indicating that the platforms need proof of authenticity.

Impact of information technology on teaching and learning during the Covid19 pandemic Although most of the content of this book chapter was written before Covid19, we could not conclude this chapter without referring to the role that information technologies have had in ensuring a seamless transition into online-only teaching during the pandemic. Within weeks universities had to migrate all their

[20] https://dtxalliance.org/

learning and teaching activities to online-only provision. From discussions with colleagues across the world we have learn that level of previous familiarity with LMS and applications (and "willingness to change" of members of staff) impacted the speed and success of the migration. However, regardless of previous preparation, all universities had to transfer as much teaching as they could online, with MS Teams suddenly being used by lecturers and students across the globe, often with just hours or minutes to learn how to use it. An extreme case was seen at the School of Veterinary Medicine and Science, Nottingham University (UK), which achieve a full-online start of the academic year for their April 2020 intake, with lecturers having only a few days' notice to migrate online their teaching delivery. At the time of writing of this article, we could see that across the world academics have adapted their courses to distance and Covid-secure teaching, using a mixture of online delivery/assessment for any subject that can be taught remotely and in person Covid-secure teaching for activities that must happen in person, e.g. nursing practical teaching [75].

Conclusion

Universities have a long history of trying to offer education to students who have different needs [76, 77]. However, regardless the technology used or the teaching method, it is interesting to observe that students sometimes complain; for them a "proper" lecture is sitting on a chair for a couple of hours while listening to the lecturer's monologue that tells them what they need to know in order to pass the exam. Though digital learning and teaching platforms do support assessment and improvement of inclusive learning and teaching, which may influence the wellbeing and quality of life of the students, for a sustainable impact, changes in mindsets have to take place for both, lecturers and students. These platforms became an unexpected blessing and saving grace when the world faced the Covid19 pandemic. We are yet to know the real impact of these new practices on the long term learning outcomes and life quality of the individuals influenced by these radical and unexpected changes.

References

1. Jackson D. Factors influencing job attainment in recent Bachelor graduates: evidence from Australia. High Educ. 2014;68(1):135–53.
2. Layer G. Disabled students sector leadership group (DSSLG) inclusive teaching and learning in higher education as a route to excellence. London: Department for Education; 2017.
3. May H, Bridger K. Developing and embedding inclusive policy and practice in higher education. York: Higher Education Academy; 2010.

4. Gioia GA, Isquith PK, Guy SC, Kenworthy L. Behavior rating inventory of executive function professional manual. Florida: Psychological Assessment Resources. Inc; 2000.
5. Wojciulik E, Kanwisher N. The generality of parietal involvement in visual attention. Neuron. 1999;23(4):747–64.
6. Ross-Swain D. RIPA-2: Ross information processing assessment. Pro-Ed; 1996.
7. Ruff RM, Niemann H, Allen CC, Farrow CE, Wylie T. The Ruff 2 and 7 selective attention test: a neuropsychological application. Perceptual Motor Skills. 1992;75(Suppl 3):1311–9.
8. Ridley Stroop J. Studies of interference in serial verbal reactions. J Exp Psychol. 1935;18(6):643.
9. Army Individual Test Battery. Manual of directions and scoring. Washington, DC: War Department, Adjutant General's Office; 1944.
10. Deutsch Lezak M, Howieson DB, Bigler EB, Tranel D. Neuropsychological assessment. New York: Oxford University Press; 2012.
11. Wechsler DA. Wechsler adult intelligence scale. New York, NY: The Psychological Corporation; 1997.
12. Berg EA. A simple objective technique for measuring flexibility in thinking. J Gen Psychol. 1948;39(1):15–22.
13. Derryberry D, Reed MA. Anxiety-related attentional biases and their regulation by attentional control. J Abnormal Psychol. 2002;111(2):225.
14. Enger Rosvold H, Mirsky AF, Sarason I, Bransome ED Jr, Beck LH. A continuous performance test of brain damage. J Consult Psychol. 1956;20(5):343.
15. MacLeod C, Mathews A, Tata P. Attentional bias in emotional disorders. J Abnormal Psychol. 1986;95(1):15.
16. Wechsler D. The measurement of adult intelligence. Baltimore, MD: Williams & Wilkins Co; 1939. https://doi.org/10.1037/10020-000.
17. Pylyshyn ZW, Storm RW. Tracking multiple independent targets: evidence for a parallel tracking mechanism. Spatial Vis. 1988;3(3):179–97.
18. Gronwall DMA. Paced auditory serial-addition task: a measure of recovery from concussion. Perceptual Motor Skills. 1977;44(2):367–73.
19. Logan GD, Van Zandt T, Verbruggen F, Wagenmakers E-J. On the ability to inhibit thought and action: general and special theories of an act of control. Psychol Rev. 2014;121(1):66.
20. Roid GH. Stanford-Binet intelligence scales. 5th ed. Itasca, IL: Riverside Publishing; 2003.
21. Rosen WG, Mohs RC, Davis KL. A new rating scale for Alzheimer's disease. Am J Psychiatry. 1984;141(11):1356–64.
22. Abigail Benton Sivan. Benton visual retention test. San Antonio: Psychological Corporation; 1992.
23. Rey A. L'examen clinique en psychologie [The clinical psychological examination]. Paris: Presses Universitaires de France; 1964.
24. Sternberg S. High speed memory scanning. Science. 1966;133(1966):652–4.
25. Delis DC, Kramer JH, Kaplan E, Ober BA. California verbal learning test. Research Edition Manual. San Antonio: The Psychological Corporation; 1987.
26. Weiss LG, Saklofske DH, Coalson D, Raiford SE. WAIS-IV clinical use and interpretation. Scientist-practitioner perspectives. Academic; 2010.
27. Alloway TP. Automated working memory assessment. London: Pearson Assessment and Information BV Translated and reproduced with ….; 2007.
28. Berch DB, Krikorian R, Huha EM. The Corsi block-tapping task: methodological and theoretical considerations. Brain Cognition. 1998;38(3):317–38.
29. Kirchner WK. Age differences in short-term retention of rapidly changing information. J Exp Psychol. 1958;55(4):352.
30. Petrides M, Milner B. Deficits on subject-ordered tasks after frontal-and temporal-lobe lesions in man. Neuropsychologia. 1982;20(3):249–62.
31. Cassidy S. The academic resilience scale (ARS-30): a new multidimensional construct measure. Front Psychol. 2016;7:1787.

32. Mayo NE, Figueiredo S, Ahmed S, Bartlett SJ. Montréal accord on patient-reported outcomes (PROs) use series–paper 2: terminology proposed to measure what matters in health. J Clin Epidemiol. 2017;89(2017):119–24.
33. Rinck M, Becker ES. Approach and avoidance in fear of spiders. J Behav Therapy Exp Psychiatry. 2007;38(2):105–20. https://doi.org/10.1016/j.jbtep.2006.10.001.
34. Alloway TP, Gathercole SE, Kirkwood H, Elliott J. Evaluating the validity of the automated working memory assessment. Educ Psychol. 2008;28(7):725–34. https://doi.org/10.1080/01443410802243828.
35. Atkins AS, Stroescu I, Spagnola NB, Davis VG, Patterson TD, Narasimhan M, Harvey PD, Keefe RSE. Assessment of age-related differences in functional capacity using the virtual reality functional capacity assessment tool (VRFCAT). J Prev Alzheimers Dis. 2015;2(2):121–7. https://doi.org/10.14283/jpad.2015.61.
36. American Psychiatric Association. Diagnostic and statistical manual of mental disorders (DSM-5®). 5th ed. American Psychiatric Pub; 2013.
37. Brown P. The invisible problem?: improving students' mental health. Oxford: Higher Education Policy Institute; 2016.
38. Thorley C. Not by degrees: improving student mental health in the UK's universities. London: Institute for Public Policy Research; 2017.
39. Houghton A-M, Anderson J. Embedding mental wellbeing in the curriculum: maximising success in higher education. High Educ Acad. 2017;68 (forthcoming).
40. The Engelhard Project. Retrieved December 29, 2020 from http://engelhard.georgetown.edu/
41. McManus S, Bebbington P, Jenkins R, Brugha T. Mental health and wellbeing in England: adult psychiatric morbidity survey 2014. A survey carried out for NHS digital by NatCen social research and the department of health sciences. University of Leicester; 2016.
42. Caul S. Estimating suicide among higher education students, England and Wales: experimental statistics. London: Office for National Statistics; 2018.
43. Melrose S. Seasonal affective disorder: an overview of assessment and treatment approaches. Depress Res Treat. 2015;2015
44. HESA. Higher education student statistics: UK, 2017/18 - Student numbers and characteristics | HESA. Higher Education Statistics Agency, London; 2019. Retrieved June 14, 2020 from https://www.hesa.ac.uk/news/17-01-2019/sb252-higher-education-student-statistics/numbers
45. Perelmutter B, McGregor KK, Gordon KR. Assistive technology interventions for adolescents and adults with learning disabilities: an evidence-based systematic review and meta-analysis. Comput Educ. 2017;114(2017):139–63.
46. Pino M, Mortari L. The inclusion of students with dyslexia in higher education: a systematic review using narrative synthesis. Dyslexia. 2014;20(4):346–69.
47. Treviranus J. Learning differences & digital equity in the classroom. 2018.
48. Rose T. The end of average: how to succeed in a world that values sameness. London: Penguin; 2016.
49. Mantle R. UK, 2017/18 – Student numbers and characteristics. London: Higher Education Student Statistics; 2019.
50. Sanchez-Gelabert A, Figueroa M, Elias M. Working whilst studying in higher education: the impact of the economic crisis on academic and labour market success. Eur J Educ. 2017;52(2):232–45.
51. Cuthbertson BH, Hull A, Strachan M, Scott J. Post-traumatic stress disorder after critical illness requiring general intensive care. Intensive Care Med. 2004;30(3):450–5.
52. Brown LA. Instructor usage of learning management systems utilizing a technology acceptance model. PhD Thesis. Montana State University-Bozeman, College of Education, Health & Human; 2017.

53. Bowe F. Universal design in education: teaching nontraditional students. Greenwood Publishing Group; 2000.
54. Burgstahler S. Universal Design of Instruction (UDI): definition, principles, guidelines, and examples. DO-IT; 2009.
55. Machado M, Tao E. Blackboard vs. Moodle: comparing user experience of learning management systems. In: 2007 37th annual frontiers in education conference-global engineering: knowledge without borders, opportunities without passports, IEEE, S4J-7; 2007.
56. Kakasevski G, Mihajlov M, Arsenovski S, Chungurski S. Evaluating usability in learning management system Moodle. In ITI 2008-30th International Conference on Information Technology Interfaces, IEEE; 2008. p. 613–8.
57. Holzer A, Govaerts S, Ondrus J, Vozniuk A, Rigaud D, Garbinato B, Gillet D. Speakup–a mobile app facilitating audience interaction. In: International conference on web-based learning. Springer; 2013. p. 11–20.
58. Chu SK-W, Kennedy DM. Using online collaborative tools for groups to co-construct knowledge. Online Inf Rev. 2011;2011
59. Yourstone SA, Kraye HS, Albaum G. Classroom questioning with immediate electronic response: do clickers improve learning? Decis Sci J Innov Educ. 2008;6(1):75–88.
60. Prasad G. Dependency-oriented thinking: volume 1 analysis and design. InfoQ; 2013.
61. Dennis TA, O'Toole LJ. Mental health on the go: Effects of a gamified attention-bias modification mobile application in trait-anxious adults. Clin Psychol Sci. 2014;2(5):576–90.
62. Mackintosh M-A, Niehaus J, Taft CT, Marx BP, Grubbs K, Morland LA. Using a mobile application in the treatment of dysregulated anger among veterans. Military Med. 2017;182(11–12):e1941–9.
63. Demeulemeester M, Kochman F, Fligans B, Tabet AJ, Thomas P, Jardri R. Assessing early-onset hallucinations in the touch-screen generation. Br J Psychiatry. 2015;206(3):181–3.
64. Shen N, Levitan M-J, Johnson A, Bender JL, Hamilton-Page M, Jadad AAR, Wiljer D. Finding a depression app: a review and content analysis of the depression app marketplace. JMIR mHealth uHealth. 2015;3(1):e16.
65. Pechenkina E, Laurence D, Oates G, Eldridge D, Hunter D. Using a gamified mobile app to increase student engagement, retention and academic achievement. Int J Educ Technol High Educ. 2017;14(1):1–12.
66. Zhu Y, Jiang H, Hang S, Zhong N, Li R, Li X, Chen T, Tan H, Jiang D, Ding X. A newly designed mobile-based computerized cognitive addiction therapy app for the improvement of cognition impairments and risk decision making in methamphetamine use disorder: randomized controlled trial. JMIR mHealth uHealth. 2018;6(6):e10292.
67. Politi-Georgousi S, Drigas A. Mobile applications. In: An emerging powerful tool for dyslexia screening and intervention: a systematic literature review; 2020.
68. Adefila A, Graham S, Patel A. Fast and slow: using spritz for academic study? Technol Knowl Learn. 2020;2020:1–21.
69. Burgstahler S. Equal access: universal design of instruction. DO-IT, University of Washington; 2008.
70. Harrati N, Bouchrika I, Tari A, Ladjailia A. Exploring user satisfaction for e-learning systems via usage-based metrics and system usability scale analysis. Comput Hum Behav. 2016;61(2016):463–71.
71. Wac K. Quality of life technologies. In: Encyclopedia of behavioral medicine. New York: Springer; 2020.
72. Wac K. From quantified self to quality of life. In: Digital health. New York: Springer; 2018. p. 83–108.
73. Patel NA, Butte AJ. Characteristics and challenges of the clinical pipeline of digital therapeutics. npj Digital Med. 2020;3(1):1–5.
74. Faggella-Luby M, Gelbar N, Dukes L, Madaus J, Lalor A, Lombardi A. Learning strategy instruction for college students with disabilities: a systematic review of the literature. J Postsecondary Educ Disability. 2019;32(1):63–81.

75. Mostyin A, Toledo-Rodriguez M. Online tools for teaching. From inclusive learning to "the way" to teach and assess during the COVID-19 pandemic. Physiol News. 119
76. Elaine Allen I, Seaman J. Changing course: ten years of tracking online education in the United States. ERIC; 2013.
77. Eskey MT, Roehrich H. A faculty observation model for online instructors: observing faculty members in the online classroom. Online J Distance Learn Adm. 2013;16:2.

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