



UNIVERSITIES OF THE FUTURE

COLLABORATIVE DIGITAL SHIFT TOWARDS A NEW
FRAMEWORK FOR INDUSTRY AND EDUCATION

Toolkit for teachers

Technologies



Partners



Teresa Pereira
(Project manager)
mtp@i8sep.ipp.pt



Maria Clavert
maria.clavert@aalto.fi



Katarzyna Bargiel
katarzyna.bargiel@pw.edu.pl



Rui Moura
rui.moura@ikea.com



Frank Russi
frank@consair.fi



Carolina Morais
carolina.morais@ani.pt



Sanja Murso
sanja.mursu@tek.fi



Wojciech Gackowski
wg@w-b.pl



Maciej Markowski
mmarkowski@pka.edu.pl



Olivier Schulbaum
olivierschulbaum@platoniq.net



Filipe Themudo
filipe@juntadigital.pt



Pedro Costa
pedro.costa@inovamais.pt



Aki Malinen
aki.malinen@aalto.fi





Author:

Artur Wilkowski, Warsaw University of Technology, Poland

Contributors:

Marcela Acosta, Aalto University, Finland

Katarzyna Bargieł, Warsaw University of Technology, Poland

Carolina Morais, National Innovation Agency, Portugal

Piotr Pałka, Warsaw University of Technology, Poland

Teresa Pereira, P.PORTO. Portugal





INDEX

1 INTRODUCTION AND FOREWORD	1
2 CURRENT SITUATION	3
<hr/>	
2.1 INDUSTRY 4.0: STATE OF AFFAIRS	3
2.2 TRENDS	3
2.3 NEEDS	4
2.3.1 Addressing modern challenges in information acquisition	4
2.3.2 Supporting collaborative work	4
2.3.3 IT-assisted teaching	4
2.4 POST-COVID EDUCATION	5
3 TECHNOLOGIES FOR EDUCATION 4.0	7
<hr/>	
3.1 TOOLS TO SUPPORT GROUP AND PROJECT WORK	7
3.1.1 Cloud storage services	7
3.1.2 Document Collaboration Tools	9
3.1.3 Documenting projects - Wiki services	11
3.1.4 Collaborative information collection, sharing and organization	13
3.1.5 Project management tools	17
3.1.6 Collaborative Design Tools	21
3.2 E-LEARNING AND BLENDED LEARNING TOOLS	25
3.2.1 Direct communication tools	25
3.2.1.1 Webcasts	25
3.2.1.2 Streaming servers	27
3.2.1.3 Teleconferencing tools	28
3.2.1.4 Webinars	29
3.2.2 Creating e-learning materials	30
3.2.2.1 Creating educational videos	30
3.2.2.2 Authoring interactive educational content	33
3.2.3 Learning Management Systems (LMS)	34
3.3 ONLINE LEARNING	36
4 SUMMARY	41
5 REFERENCES	43
<hr/>	
5.1 BIBLIOGRAPHY	43
5.2 NETOGRAPHY	44



Introduction and foreword



1 Introduction and foreword

This toolkit for teachers – technologies is supplementary material for the toolkit for teachers. It comprises a range of digital technologies that can be used to support and successfully implement modern and innovative initiatives in education. Software applications that support such important areas of modern education such as collaborative work, remote collaboration, information collection, sharing, structuring, as well as moving portions or the entire learning process to the online format, are described.

New educational needs may be regarded as a motor driving the development of new IT solutions that might address them. However, the opposite also happens – the whole new world of emerging IT Technologies introduces completely new educational needs.

E.g. the introduction of Massive Open Online Courses (MOOCs) can be regarded as a direct answer to the students' need for selective learning, carried out by the best academic centers and not limited by geographical constraints, physical limitations on the number of enrolled students, or high price. On the other hand, the abundance of information sources, thanks to the Internet, encourages the re-evaluation of educational principles themselves: from education based on memorizing information to education based on knowledge understanding and application, as well as on information selection and structuring.

Therefore, the development of IT and Communication technologies may be regarded as one of the major catalysts for the ongoing process of adjusting education to the needs of the modern world. The selection of appropriate IT tools for teachers and students can greatly benefit the application of the process.

The content of this toolkit for teachers (technologies) consists of or is associated with the selection and description of technologies that support:

- group project work,
- e-learning and blended learning tools.

Artur Wilkowski, Warsaw University of Technology



Current situation

2 Current situation

2.1 Industry 4.0: state of affairs

Industry 4.0 is the new paradigm for production, organization, and business model development. In many publications it is often identified with the use of certain technologies such as augmented reality, simulation, autonomous vehicles and robots, additive manufacturing, industrial robotics, mechanical arms, distributed ledger systems, big data analytics, Industrial IoT, mobile computing, cloud computing, edge computing, multi-agent systems, software defined industrial networks, and device to device communication (Chen et al., 2017, McQuaid and Lindsay, 2005, Passow and Passow, 2017, Rautavaara, 2015, Adolph et al., 2014). The application of these technologies certainly changes the approach to production and precipitates the swift transformation of business models (State-of-Maturity Report, 2019).

Our life and work culture have changed rapidly in one generation. One of the reasons were the new technologies, and the changing social and economic aspects that accompanied them. Those aspects (State-of-Maturity Report, 2019) are telecommuting, emerging platform economies, the rise of freelancing and consultant-style services, etc. The natural outcome of this process is the increasing interdependence of interpersonal relationships between employees (Hofmann and Ruesch, 2017). The result is a strong need for future employees to learn how to cooperate, how to work as a team and how to communicate. What's more, the rapid development of ICT technology means that these groups may work remotely, which generates a need for new technologies to ensure effective communication, cooperation, remote team management and the use of digital tools. The selection of the digital technologies is described in this toolkit.

2.2 Trends

In the State-of-Maturity Report (2019), an overview of trends and challenges in technology and education was discussed.

The future trends and related challenges to the implementation of Industry 4.0 were presented, based on previously conducted interviews and on the initiatives that arose (from national to grassroots) as a result. The future trends and related challenges were grouped in the following areas:

- education and lack of skilled people in technology,
- lack of vision regarding the value of technology,
- promoting entrepreneurship for innovation and new business models,
- speed, innovation, and collaboration over exclusive rights,
- platform economies and the future of work, and
- regulations.





Moreover, the State-of-Maturity Report (2019) presents the relationships between the mentioned trends and challenges, how they might relate to each other.

2.3 Needs

The most important developments in technologies backing up the introduction of innovations in education are briefly described in the following sections. They are based on several studies, benchmarks (Benchmarking report, 2018) and events connected to the project Universities of the Future (Ignition events, Blueprint enabling events).

2.3.1 Addressing modern challenges in information acquisition

Any kind of research work at any level (students, teachers or researchers) entails the collection of a significant amount of information. Due to modern information technologies and the Internet, the main difficulty in this process (in many areas) shifted from the problem of finding information sources to the problem of selecting, filtering and structuring the thousands of available pieces of information. Information must not only be collected, but also effectively shared between team members, maximizing both the transmission speed and overall understanding. These can be identified as serious challenges faced by researches and by their supporting applications.

2.3.2 Supporting collaborative work

While collaborative work is now standard in business, many university programs still concentrate on individual achievements and not on group work performance. However, current trends are also putting much more stress on collaborative work and collaborative design. Although face-to-face contact between team members is still regarded as the most efficient form of teamwork, there are some successful attempts at remote versions of collaboration.

In either case, these activities can and should be supported by software tools. Some uses include project management and documenting, data sharing, direct communication, and creative and collaborative design.

2.3.3 IT-assisted teaching

The ongoing transition from teacher-centered to student-centered learning implies increasing independence of and selectivity by students regarding the knowledge they want and need to acquire. In the context of problem-based learning approaches, classical static structures of education programs become largely inefficient. Even within a single course, modern students may want to choose some chapters that are more interesting to them than others. These needs can be addressed by modern information and communication technologies, specifically by moving some parts of the teaching process into the online world.

Recently, MOOC platforms (e.g. Coursera <https://www.coursera.org/> or EdX <https://www.edx.org/>) greatly benefited from this trend, giving students both the opportunity to select interesting material



and access to the best specialists in the given field. However, there are some other possible paths in addition to MOOCs. Even now, many universities provide entire university programmes online (see e.g.: <https://okno.pw.edu.pl/>). Another interesting option is blended learning. In this approach, in addition to direct contact hours, virtual tools are also used (e.g. a volume of materials is stored online, so that students can access them and go back to the materials that are most interesting to them).

Software applications supporting such activities include applications for preparation of course materials (e.g. videos and interactive presentations), teacher-student communication tools (webcasts, webinars) and systems for the management of the learning process (LMS).

2.4 Post-Covid education

The year 2020 challenges us to bet on the dynamization of virtual spaces. If for years digital tools have made internationalization, cooperation, coordination of distributed communities, and remote learning possible, the Covid-19 pandemic makes us rethink digital encounters not as secondary resources, but rather as the only way we have at the moment to provide education, host debates, co-create projects, and get organized. In the selected material, IT tools to support online education are briefly presented.



Technologies for Education 4.0

3 Technologies for Education 4.0

The tools for supporting education discussed in this chapter are divided into two major sections. The first section includes tools that can be generally described as “tools to support group and project work”. This includes tools needed for collaborative work on some problem, like collection and structuring of information, project management, sharing of documents, or collaborative design. So, this section mainly is devoted to tools that can be used by groups of students (or academia in general). The second section, “E-learning and blended-learning tools”, focuses on teachers and the tools that can be directly applied to introduce IT innovation to the teaching process. These include authoring electronic educational materials, electronic communication with students, and teaching courses online.

The distinctions between different subcategories of tools are often blurred since many tools typically fit into several different categories. To keep things simple, specific categories were assigned based on personal experiences with the suitability of specific tools to specific parts of the educational process, and not necessarily on their official alignment.

Since software applications are meant to be used by students and academia, the affordability of particular applications was an important factor for selecting the tools. So, applications with reasonable free plans or academia discounts were generally preferred over even more powerful but more expensive ones.

3.1 Tools supporting group and project work

3.1.1 Cloud storage services

File sharing services available online are one of the main tools facilitating work within academia – both for teachers and student groups. There are plenty of providers of this kind of services, among which the most well-known probably is MS OneDrive (<https://onedrive.live.com>), Google Drive (<https://drive.google.com>) and Dropbox (<https://www.dropbox.com>).

Cloud storage enables users to store their files remotely on the Internet and easily synchronize a local copy of their files with their remote counterpart. Each file that user changes in the shared folder can be automatically synced both with its remote version as well as with the version on all the other devices of the given user. Thus, cloud storage can be regarded as an efficient device-sync and backup utility.

Typically, remote directories can also be shared with other users, so they may be used as workspaces dedicated to sharing files between workgroup members working on the same project. Some services (such as Google Drive or MS OneDrive) provide online document editors, improving the collaborative aspect.

In addition, cloud storage solutions usually make it possible to review the history of file change, thereby functioning as a type of version control system.



Regarding the needs of academia, the cloud storage services should be evaluated with respect to e.g:

- costs (the existence of a free plan / pricing of paid plans),
- available storage space for each plan,
- file versioning (present/absent, limited/unlimited history),
- directory sharing and permissions,
- portability of file sync application.

Some of the most notable **free** storages include Google Drive (up to 15GB, but shared with all other Google services), Dropbox (up to 2GB), and MEGA.nz (<https://mega.nz/>, even 50GB), but there are also some new players on the market such as pCloud (20GB).

For a comprehensive review of current Cloud Storage Solutions see: <https://www.cloudwards.net/comparison/>.

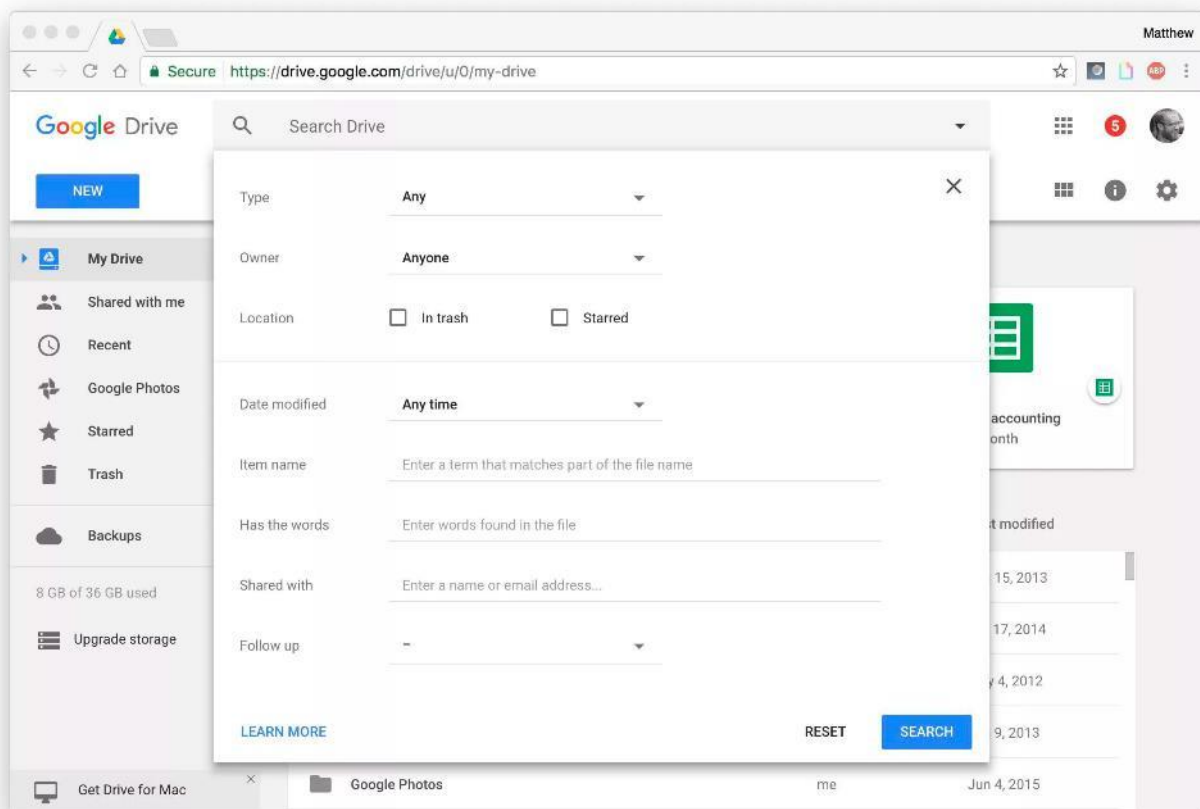


Figure 1 Google Drive. Source: <https://www.cnet.com/how-to/hidden-features-of-google-drive/> (accessed: 2019.06.26)





3.1.2 Document Collaboration Tools

Document Collaboration Tools enable groups of users (e.g. teachers) to work together remotely on a single document. In most cases, a specialized software that enables collaborative work on multiple input devices (such as desktops, laptops or mobile devices) is provided. Applications also frequently supply a generic web interface, ensuring that work becomes increasingly independent from specific hardware that has the right software installed. Document collaboration tools can encompass many different office editor tools. The most popular ones are text editors, spreadsheets and presentation editors.

In a typical scenario, the whole group is working on a single document. All changes made by a single user are immediately visible to other users. This kind of tools may be used with video-conferencing software.

Document collaboration often goes together with cloud storage services, so users can store different versions of their files in a cloud and use appropriate collaborative editors when needed (e.g. Google Docs (<https://docs.google.com/>), Google Drive (<https://drive.google.com/>), MS Office Online (<https://office.live.com/>), or MS OneDrive (<https://onedrive.live.com/>).

Some benefits of using document collaboration tools are:

- very fast communication of ideas to other users,
- some brainstorming capabilities (there are better tools however),
- extremely reduced document integration times (whole team is working on the most current document prototype).

Some risks in the usage of document collaboration tools are:

- the need for a coordinator (need to establish rules, resolving conflicting ideas when they occur),
- some people may be intimidated by the perspective of editing content online and may prefer a more traditional workflow of prototyping-verification-submission.

Some most widely used collaboration tools include:

- Google Docs (Free) (<https://docs.google.com/>),
- Bit.AI (Free for up to 50 members) (<https://bit.ai/>),
- Atlassian Confluence (5\$ per user) (<https://www.atlassian.com/software/confluence>),
- MS Office Online (different pricing models) (<https://office.live.com/>).

In order to comparing selected document collaboration tools, visit <https://blog.bit.ai/document-collaboration-tools/>



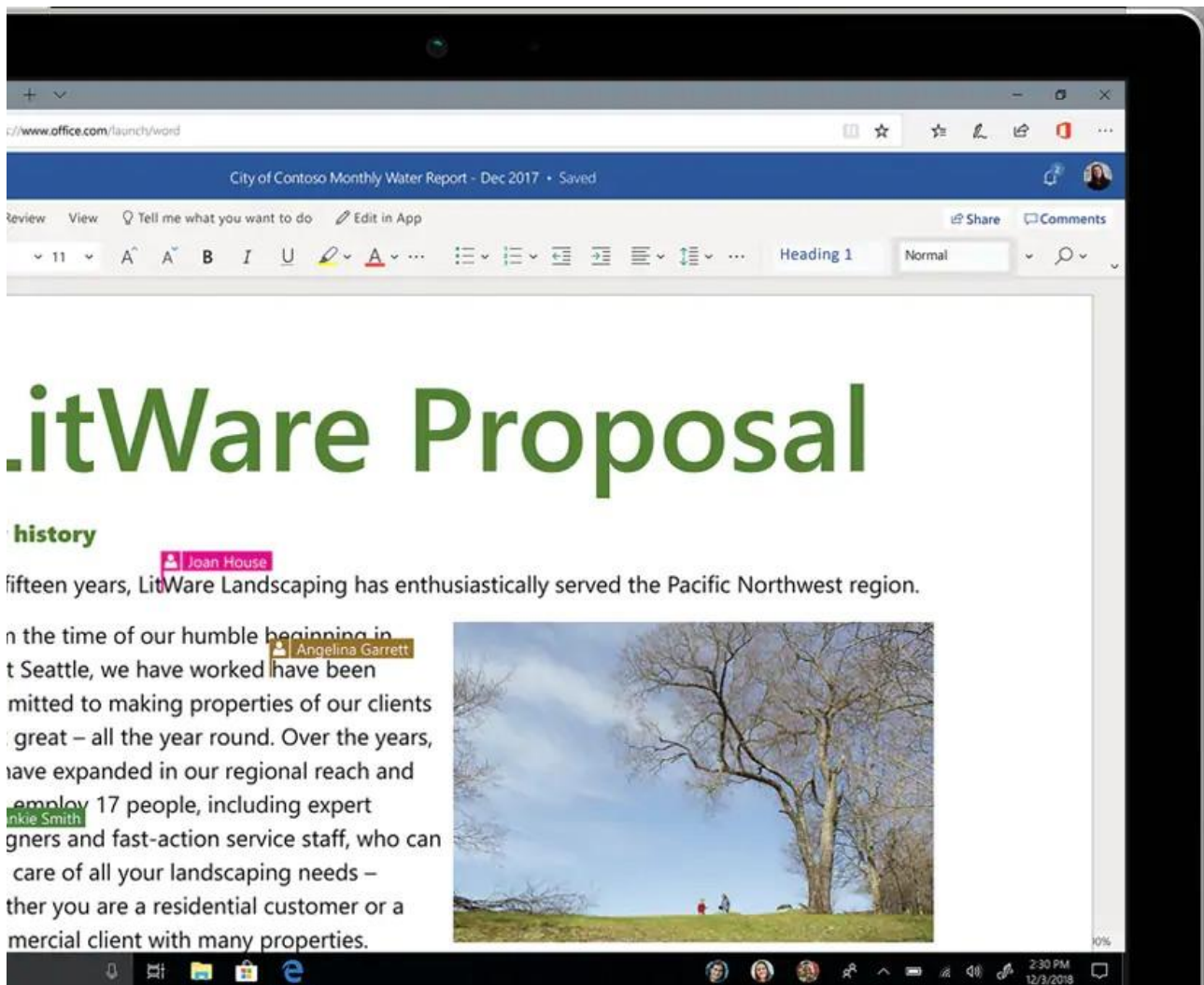


Figure 2 Word Online. Source: <https://products.office.com/pl-pl/office-online/documents-spreadsheets-presentations-office-online>



3.1.3 Documenting projects - Wiki services

Wiki services may be regarded as a type of *Document Collaboration Tools*. However, due to the excellent readability of output documents, connected to the natural utilization of hypertext and largely standardized document structure, appearance, and interface – this kind of tools are more specialized. They are most often used for highly structured documents intended for non-linear reading and quick navigation and are excellent for encyclopedia applications as well as for documenting projects.

Some prominent features of Wiki systems can be identified:

- documents are published in the form of web pages,
- markup languages are used for formatting,
- hypertext links are intensively used and easily managed,
- native Wiki markup languages (Wikitext, Markdown) are simpler compared to other popular web page formatting languages (e.g. HTML and CSS),
- documents are collaboratively edited by (possibly large) groups of users,
- very often the content is mixed with the discussion board.

Some popular Wiki management systems are UseModWiki (<http://www.usemod.com/cgi-bin/wiki.pl>), MediaWiki (<https://www.mediawiki.org/wiki/MediaWiki>) or DokuWiki (<https://www.dokuwiki.org/dokuwiki>). Wiki systems are typically distributed as free Open Source solutions.



DokuWiki
It's better when it's simple

Search [] []

Recent Changes Media Manager Sitemap

Trace: - starter

Learn about DokuWiki

- Features & reviews
- Installation guide
- User manual & syntax
- Release notes
- FAQ

Advanced Use

- Extensions
- Development manual

Corporate Use

- Get support
- Donations

Our Community

- Get involved
- User forum
- Newsletter
- Development mailinglist

Follow us on Facebook, Twitter and other social networks.

Our Privacy Policy

Starter Template

The template that gets you started

Compatible with DokuWiki 2018-04-22 "Greebo"

Download

Report bugs

Donate

Table of Contents

- Starter Template
- Download and Install
- Configuration
- Event hooks
- More Info
 - To Do
 - Credits
 - Changes
 - Demo
- Templates based on Starter
- Comments
 - How to translate this theme?
 - How to insert a logo image instead of text?
 - CSS bug w/ zoom plugin
 - Tools hidden - can't login
 - Backlink for Discussion Has Wrong Page ID

Last updated on 2015-08-01

Repository Source

Similar to benjamin, twigstarter

Tagged with discussion, sidebar, simple, start, userpage

By Anika Henke

abc ipa blockquote loadskin purplenumbers wrap wikipediasnippet ach unformattedcode fontface and 5 more

The **Starter Template** is designed to be the starting point of your custom template. It has a lot of inline comments in the code which should explain many things. It focuses less on design, but more on maintainability.

It is done in a way which lets you worry less about DokuWiki's core styles. Instead you only need to care about the five main styles:

- basic.css**: You probably only want to touch this if you'd like to change general font sizes and font stacks.
- structure.css**: You probably only want to touch this if you'd like to change the general structure of the site (to 3 columns or have different widths or make everything fluid or switch the sidebar to the right, etc).
- design.css**: Here you can style all the bits that surround the page content.
- content.css**: Here you can style all of the page content.
- mobile.css**: Here you can style all of the changes for mobile devices and smaller screens.

You can find further advice on How to create an easily maintainable DokuWiki template written by Andreas Haerter (based on a former blog post by Michael Klier).

Refer to [Template Development documentation](#) for general information.

Download and Install

- For DokuWiki version 2014-05-05 (Ponder Silbbons) and later: Use the extension manager to install this template.
- For Binky or Weatherwax: You can download an older version.
- If you're interested in a more stripped down version of the template, you can use the "minimal" branch. That version hardly uses any CSS at all and doesn't include any additional functionalities.

Refer to [template](#) on how to install and use templates in DokuWiki.

Figure 3 DokuWiki: <https://www.dokuwiki.org/template:starter> (accessed 28.06.2019)



3.1.4 Collaborative information collection, sharing and organization

This very broad category of tools aims at effective sharing of data and ideas between users. For better productivity, the tools belonging to this category often also enable efficient collection of data (i.e. through integration with Cloud Services) and facilitate the structuring of data and ideas. Practical systems are frequently supplemented with some project management modules.

There are several philosophies for data structuring used in this kind of tools and some dominant ones include:

- Kanban-style boards – allows the user to organize data and ideas in the form of sticky notes. The sticky notes can then be further organized into columns (categories). Users can freely move sticky notes between categories. In a computer-version Kanban board, the notes are enhanced to include almost any type of multimedia content. The original idea of the board introduced three columns (to-do, doing, done) – to track work progress. However, in modern tools the actual organization of the data is only limited by the imagination and the needs of the project team. One of the most successful tools implementing Kanban-style boards is *Trello*.
- Conversation-based tools – allow the users to organize data in the shape of conversations (chats). The observation underlying this idea was that conversation is the most natural form of communication between users. Therefore, most people find it easy and natural to attain information by tracking a conversation thread. Though some problems were observed in this approach, including issues concerned with the re-organization of information while nonetheless maintaining its logical structure, there are some successful applications using exactly this concept, e.g. *Slack*.

Regarding the needs of academia, we can pinpoint some expectations for the mentioned tools:

- easy setup – e.g. access via web interface and mobile application,
- features that facilitate collecting information from common sources (e.g. simple copy-and-paste or drag-and-drop for files or Internet links),
- efficient information organization (using e.g. Kanban-style boards or Conversations principle),
- efficient means for structuring and re-structuring information (characteristic for Kanban-style boards),
- good data visualization (e.g. automatic creation of thumbnails containing text and pictures).

Data collection, sharing and organization applications have proven to be excellent tools to support the work of student project teams. Applications of these tools often include the performance of preliminary „desk” research for a project. The data can be quickly located on the Internet (as files or webpages) and immediately shared between students. Good visualization capabilities make the information immediately adoptable by team colleagues. If Kanban-style boards are employed, the research results can be easily filtered and re-structured afterwards.



This kind of tools can also be used to a certain extent as a knowledge base at virtually all stages of the project. While knowledge structure and order enforced by *Wiki Systems* is excellent for documenting prototypes and technical solutions closer to the end of the project, the tools discussed here seem to be more suitable for both the early and middle stages of the project, when the exploration of ideas and solution spaces as well as the creative design process take place.

Gathering all the available knowledge in one place is very helpful in successful project management, as well as student project supervision and facilitation by the academic staff.

Example: *Kanban-style board – Trello* (<https://trello.com/>)

Trello is probably one of the most commonly used tools for collecting, sharing and organizing information based on Kanban-board principle. It started as a system for organizing post-its but was developed well beyond that. Some prominent features offered by Trello include:

- the information is organized into post-its, which may contain almost any type of multimedia content; post-it notes are further organized into columns (categories) – each note can have multiple attachments or associated discussions,
- very effective way of presenting information, with the automatic creation of well-balanced headlines and thumbnails – the user can grasp the general meaning of the presented information at a first look and get more details after a double-click,
- very effective Kanban-style way of (re-organizing) information, by dragging sticky-notes between columns,
- very fast information collection from common sources (webpages, files) using the drag-and-drop principle, an easy way to include cloud storage resources (Google Drive, Dropbox).

In addition to its knowledge-based character, Trello is often advertised as a basic project-management tool. Tasks (post-its) can be assigned to groups of users and task progress can be monitored. However, in the current version, organizing a multi-level task hierarchy is very hard and users are not given their own task lists for review. Gantt charts are available only as a power-up. While Trello can easily create thumbnails of images and headlines for webpages, its capabilities for „thumbnailing“ different file types are not so well developed as e.g. in *Slack* (<https://slack.com>).

The free version of Trello has some limitations (e.g. 10MB of attachment size) but the number of projects and users is currently unlimited.



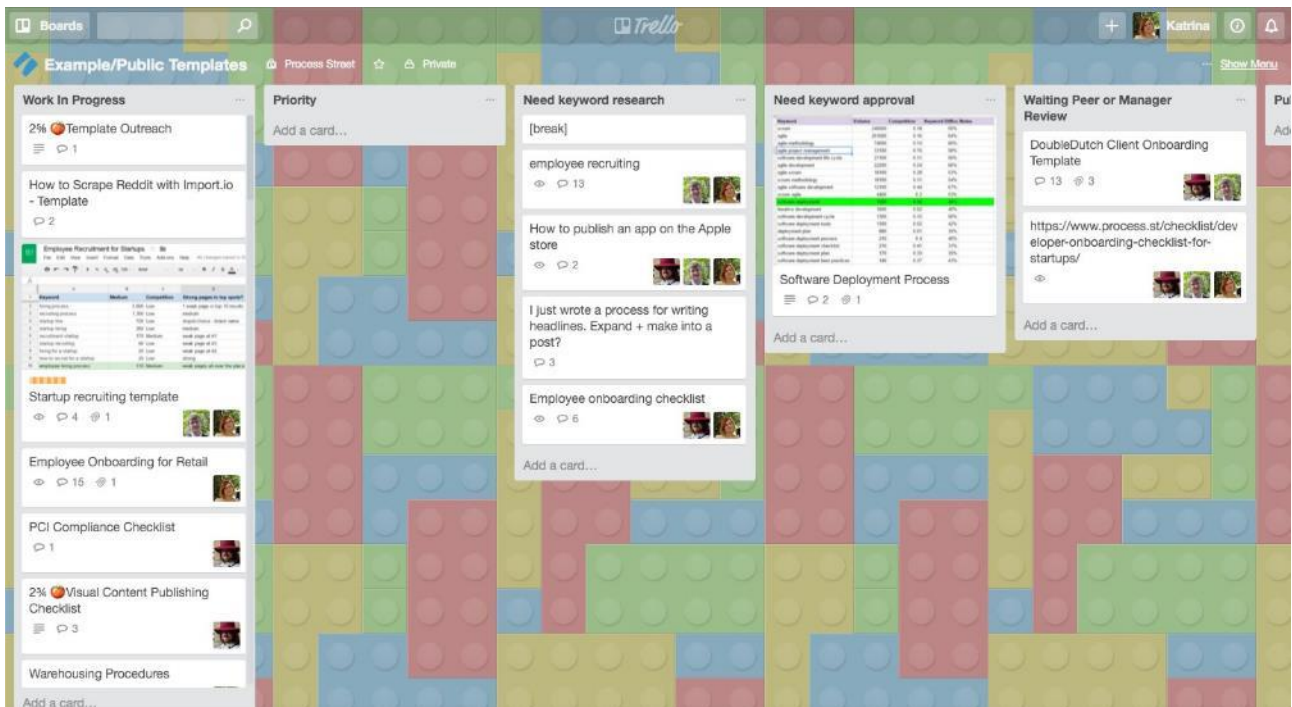


Figure 4 Trello (source: <https://www.process.st/trello-vs-asana/>, accessed on 28.06.2019)

Example: Conversation-based tool: Slack (<https://slack.com>)

Slack is advertised as a collaboration hub, but essentially it is a chat-based application with significantly developed features for handling different message attachments. Discussions in a single Slack Workspace are divided into a number of channels both private and public. A message can be sent generally to the channel or to a specific thread started by some message. The most prominent features of Slack include:

- excellent handling of message attachments: Slack is able to create a meaningful thumbnail virtually for any file type or link, some links can be opened inside the conversation (e.g. playing a movie),
- excellent search facility: attached files are automatically parsed by the Slack engine and each search query is performed both within messages themselves and within attached files.

The visibility of the information is more linear than in Kanban-style solutions, so somewhat less information is immediately visible (without scrolling). Some critics point out the difficulty of re-organizing Slack messages. While messages can be easily copied to different channels, it is not easy to maintain the integrity of conversations during such an operation.



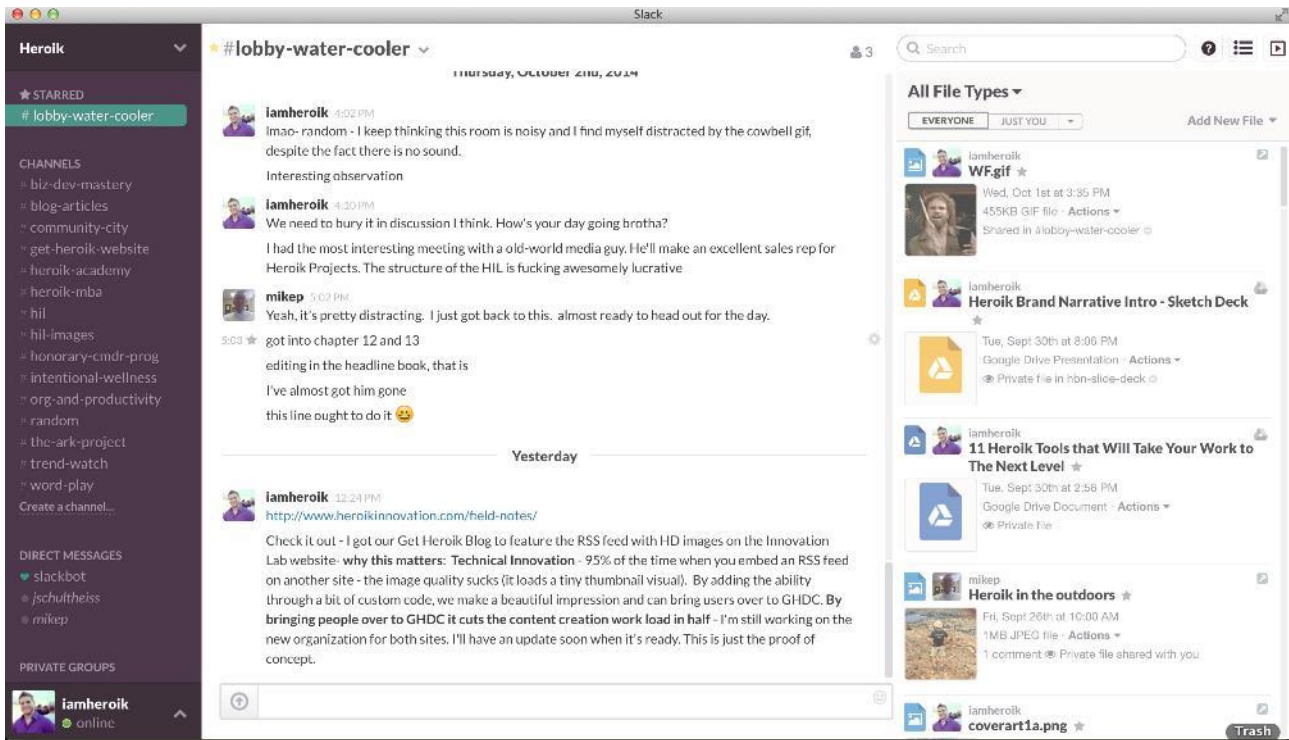


Figure 5 Slack (source: <https://getheroik.com/lean-tools-that-will-take-your-team-to-the-next-level/slack-screenshot/>, accessed on 28.06.2019)



3.1.5 Project management tools

Good project management is a must for any successful project, whether there is a large corporation or a small student project involved. A plethora of great project management applications is available. However, these are often quite expensive and aimed at business use. In this work, we concentrate on solutions that are affordable for teacher and student use.

Some features that could be expected from a good project management tool used by academia are:

- creating tasks, setting task due dates, assigning tasks to particular individuals and marking tasks as solved,
- scheduling tasks and monitoring execution (e.g. user task lists),
- task organization features, creating subtasks, making task dependencies,
- task dependency management and visualization (e.g. Gantt charts),
- unified web interface and mobile application,
- data storage features – each task can have a detailed description with different attachments; (where e.g. task results can be stored),
- simplicity, steep learning curve.

It is difficult to find free tools to fulfill all the above-mentioned needs. An important feature that is often missing is an elastic organization of complex task structure. Free versions are typically limited with respect to the maximum number of users or projects.

On the other hand, many collaborative tools offer some kind of project management, either by simply assigning tasks or by setting deadlines (e.g. Trello).

Some popular and simple project management tools include *Asana* (<https://asana.com/>), *Basecamp* (<https://basecamp.com/>), *Casual* (<https://casual.pm/>), *Teamweek* (<https://teamweek.com/>) (free for max. 5 users), and *Redmine* (<https://www.redmine.org/>).

Example: *Asana* (<https://asana.com/>)

Asana is a freemium software, and one of the most affordable tools for small teams. It sets a limit of 15 users for the free version and has a number of functionalities removed. Here are some features offered by Asana:

- two methods of task organization:
 - a classical task-list layout,
 - a more modern Kanban-style board,
- integration with cloud services for sharing data (Google, Dropbox),
- many useful features for task management (to-do task list, calendar, subtasks).



Unfortunately, a free version does not allow to make complex task dependencies (only 1-level subtasks) and visualize tasks in the shape of a timeline chart (similar to Gantt chart). These features are available in the Premium version. The basics of Asana are quite simple to grasp and a 15-user limit is not harsh, so the workflow can be quickly adopted by student teams. Premium versions of Asana cost 9.99\$ a month per user. The Kanban style layout makes Asana somewhat similar to Trello, but Asana is not as effective for data collection yet (limited thumbnail display, not automatic interpretation of urls).

There are several other project management tools utilizing the Kanban layout. One is of course Trello (<https://trello.com>), and others include *Clarizen Go* (<https://go.clarizen.com/>), *Paymo* (<https://www.paymoapp.com>), *Kanbanize* (<https://kanbanize.com>), and *Monday.com* (<https://monday.com/>). For a full selection, see: <https://thedigitalprojectmanager.com/best-trello-alternatives-top-kanban-tools/>.

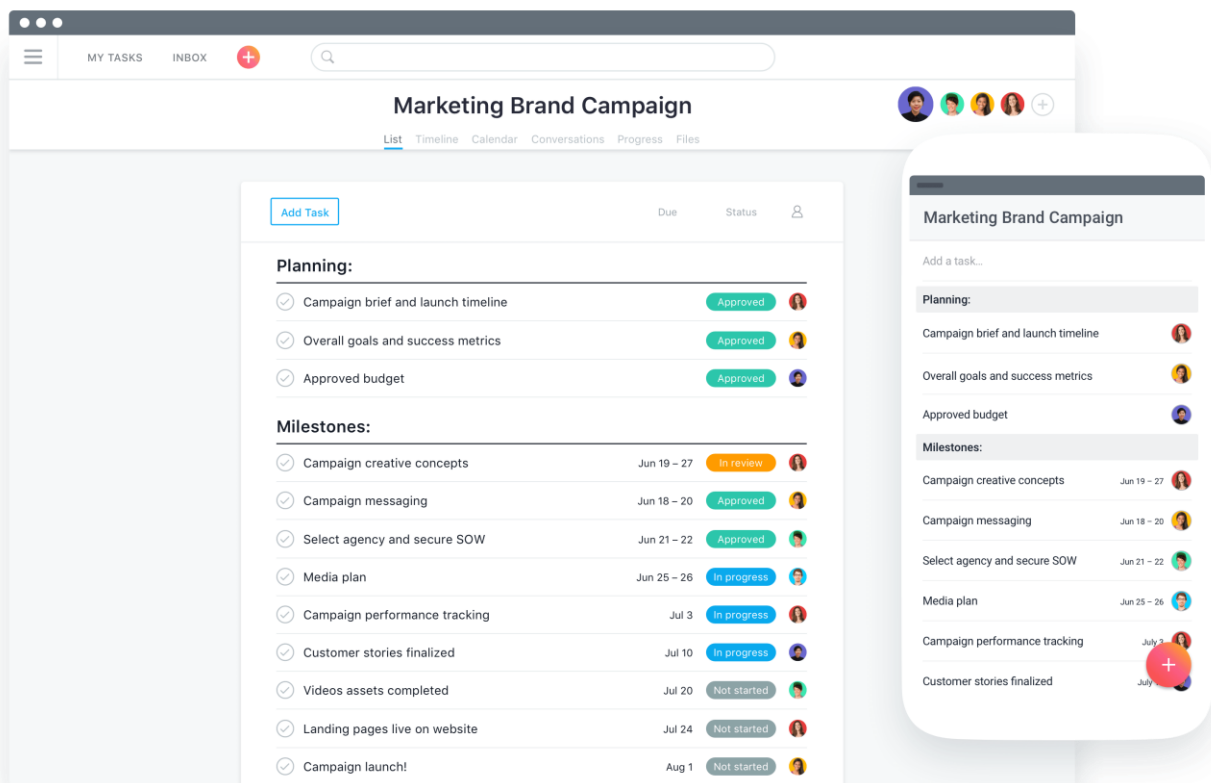


Figure 6 Asana – List Layout (source: <https://asana.com/product>)



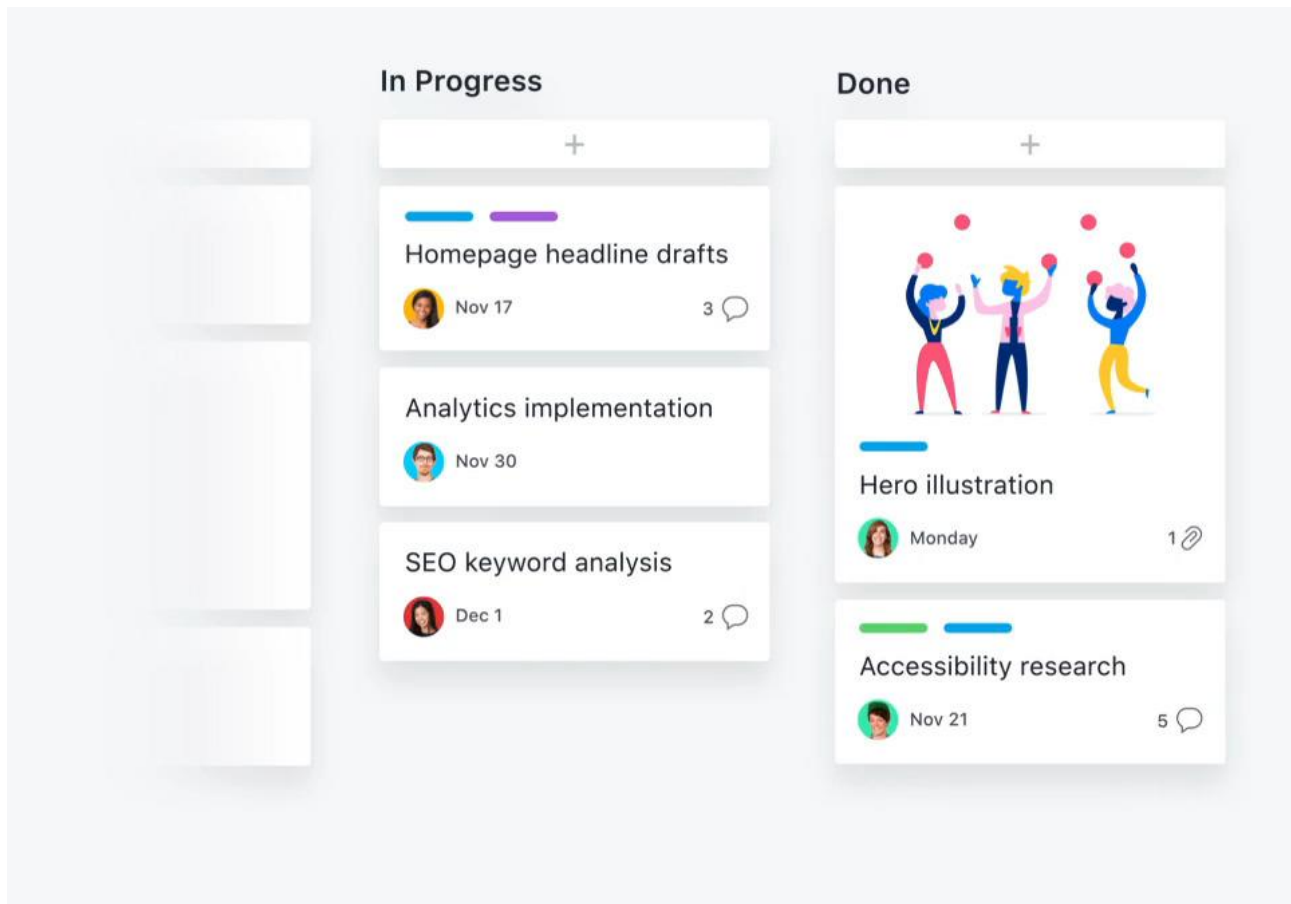


Figure 7 Asana – Board Layout (source: <https://asana.com/product>)

Example: Redmine (<https://www.redmine.org>)

Redmine is an OpenSource and Free project that originated as a bug tracker for controlling application development. Since then the project has evolved and can be regarded as a fully-fledged general-purpose project management software. User interface is not as friendly as in the case of Asana, however the set of features is impressive (especially for free software) and include:

- defining task dependencies without limitations,
- Gantt diagrams,
- Wiki pages, RSS channels,
- storage of files and documents,
- application issues (bug) trackers.

Redmine is harder to learn than Asana and less intuitive, so it would rather not be the first choice for short student projects. However, in the case of larger, especially technically-oriented projects – involving more people and time, Redmine should definitely be considered.

Note: Although Redmine is a free application, one must still consider the costs of hosting the application (making it accessible through the Internet).

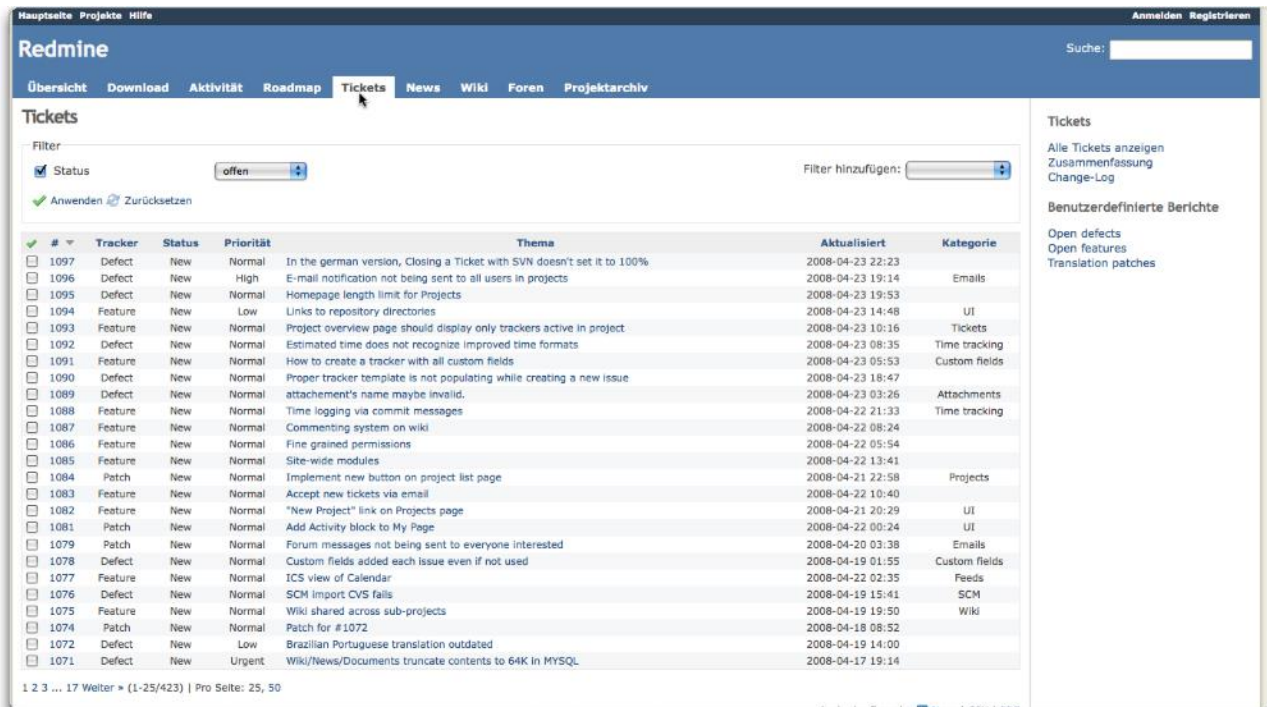


Figure 8 Redmine – Classical View (source: <https://www.getapp.com/project-management-planning-software/a/redmine/> – last access 30.06.2019)



3.1.6 Collaborative Design Tools

Right at the core of most innovative processes such as Design Thinking is collaborative design. Collaborative design is strongly founded on visualization and structuring of ideas complying with different creative design tools such as Map of Empathy, Mind Map, Brainstorming Canvas, Business Model Canvas, and many others.

Even though most teams find face-to-face collaboration to be the most effective and inspiring, and blackboards, whiteboards, flipcharts and post-its remain the main technical equipment for the process, there have been some successful attempts at moving the whole process online. In this sort of scenario, team members do not have to physically meet to design something collaboratively but instead use a specialized application that creates an environment as close as possible to face-to-face collaboration.

Participants of online creative collaboration are equipped with desktop or laptop computers or tablets, touch-sensitive screens, and direct communication hardware (camera, headset). They can connect via one of the online creative collaboration applications and perform different types of co-design activities (e.g. collaboratively create a Mind Map or an Empathy Map or do brainstorming).

Such specialized collaborative design applications typically concentrate on visual aspects of designing, so they offer visual tools for co-creating different kinds of sketches, drawings or diagrams. For best productivity they are typically supplemented with direct communication and conferencing software such as *Skype* or *Slack*.

Performing the collaborative design process online has received mixed reviews. On the one hand, it can remove spatial constraints from the creative process and facilitate the organization of design meetings, when one or several team members are not physically available (but can be remotely connected). On the other, it has been reported that, due to technical obstacles and lack of physical proximity to other team members, it is easy to lose a creative momentum very important for this kind of process. For details see: <https://blog.mural.co/2015/12/15/getting-into-remote-design-thinking-with-mural> where an (overall positive) evaluation of online Design Thinking process was conducted.

Some more mature applications that enable online Collaborative Design are *MURAL* (<https://mural.ly>), *Miro* (formerly *RealTimeBoard*, <https://miro.com/>), *Spacedeck* (Open Source license, <https://github.com/spacedeck/spacedeck-open>), *Lucidchart* (<https://www.lucidchart.com>) or *Sketchboard.io* (<https://sketchboard.io/>).



Example: Mural.ly (<https://mural.ly>)

Mural.ly is one of the most well-known tools for online collaborative design. There are several features distinguishing this application:

- impressive number of design templates,
- fairly simple and non-overwhelming user interface,
- tools that automatize brainstorming and idea selection (voting),
- excellent tools for integrating multimedia content from different sources, easily creating thumbnails of webpages and files comparable to that of Slack,
- integrated Internet search tools.

Mural current pricing is 12\$ a month per team member. However, an academic program is available that enables the free use of Mural for non-commercial purposes.

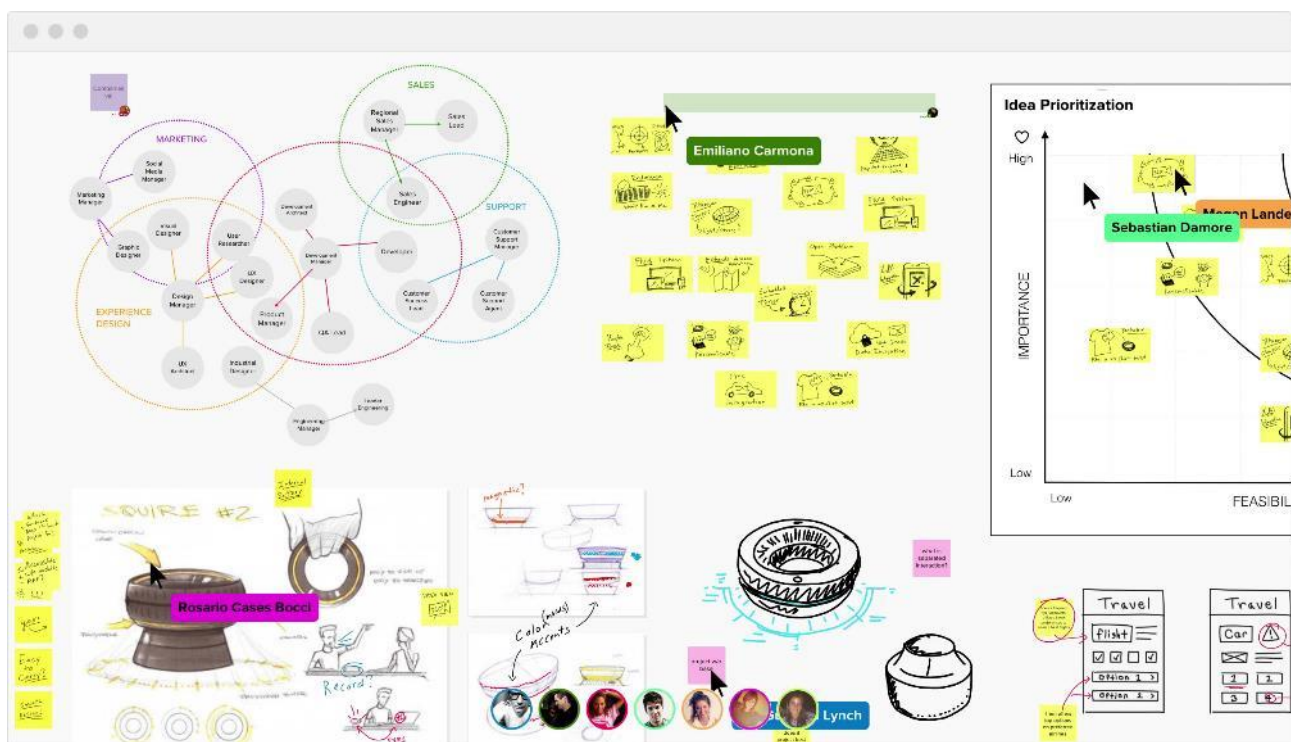


Figure 9 Design interaction in Murall.ly (source: <https://mural.co/> – last access 30.06.2019)

Example: Sketchboard.io (<https://sketchboard.io/>)

Sketchboard.io can be regarded as a somewhat simpler alternative to Mural. Some basic edition and collaborative design options are available for free. In the free edition there are limitations concerning export options available to the user. However, for most short student projects, Sketchboard.io should be sufficient.



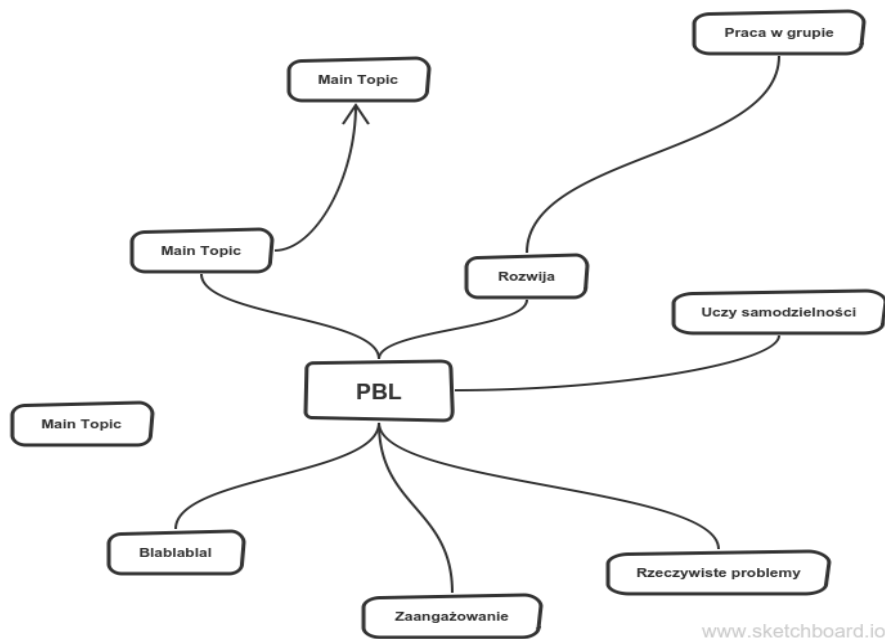


Figure 10 Sample Mind-Map designed with Sketchboard.io

Example: Miro.com (<https://miro.com/>)

Miro is an online, free and cross-device whiteboarding tool that facilitates collaboration among distributed teams while online working. The tool supports integration with other popular tools, e.g. Google Drive, Dropbox, MS Teams, or Trello. Using Miro, it is very easy to draw different kinds of diagrams, organize a brainstorm or organize project arrangements and requirements in one place.

The greatest advantage of working with Miro is the ability to involve many participants at the same time, moreover you can follow the mouse cursor movement of each of them. In that each participant can actively take part in the creation of diagrams, add own ideas and comments.

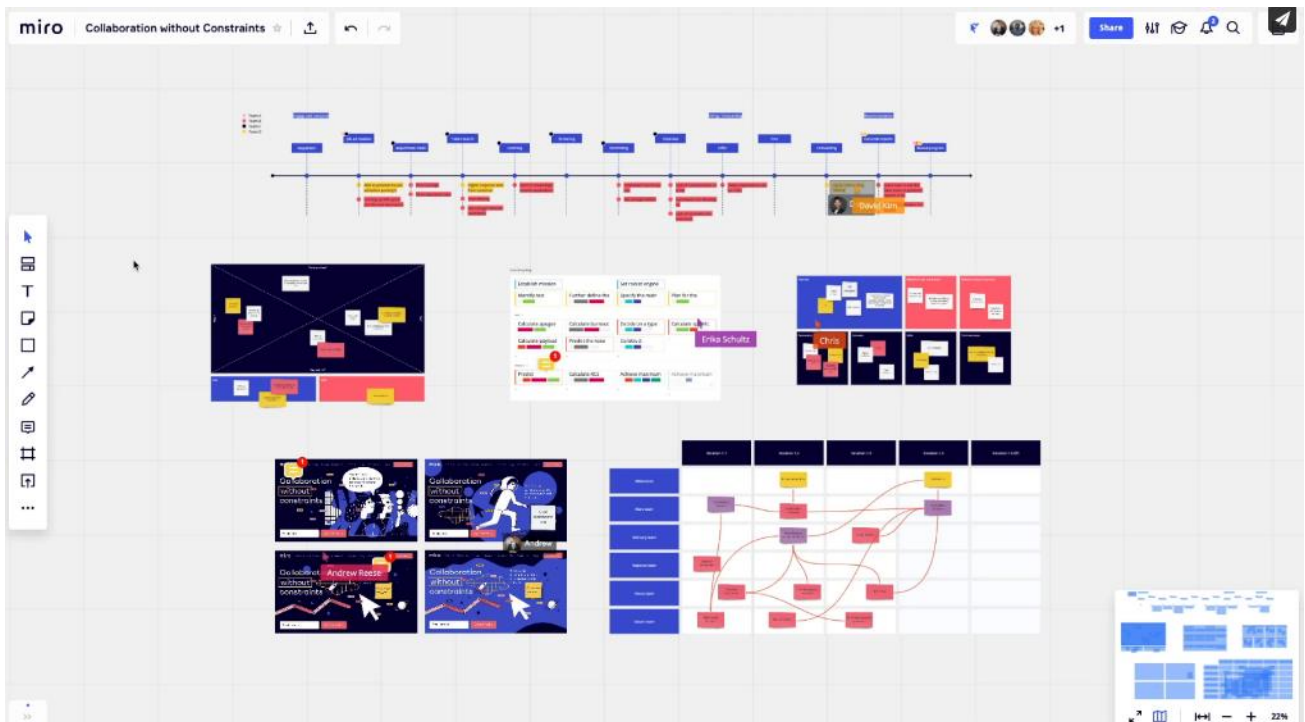


Figure 11 View of the board while many people are working at the same time (source: <https://help.miro.com/> – last access 30.03.2021)



3.2 E-learning and blended learning tools

3.2.1 Direct communication tools

Although a face-to-face contact between teachers and students is still considered important, younger generations find meeting in a virtual space almost equally natural. Direct face-to-face contact can be (at least partially) substituted by technologies that enable audio and video streaming. In this way teacher can reconstruct the classroom learning experience using only means of remote communication.

The tools discussed in this section can be roughly divided into (partially overlapping) categories:

- Webcasts – which assume mostly unidirectional communication,
- Teleconferences – which enable online discussion between many parties,
- Webinars – essentially teleconferencing tools enriched with some seminar-specific features.

We will now shortly characterize each category and provide specific examples of software solutions.

3.2.1.1 Webcasts

The Webcast can be regarded as a one-to-many live presentation that is delivered to the end users by Internet streaming. Typically, the person presenting is the only active side of the transmissions, although some return channels (e.g. chat) are also possible. A Webcast may consist of video camera transmission, voice transmission, computer desktop transmission, and additional multimedia content prepared offline.

Webcast applications vary. They can substitute classical lectures, be used to promote and broadcast interesting events, or they can be used as auxiliary material for the exercises (e.g. demonstrating the use of some specialized application). If needed, webcasts can also be transmitted from random locations using mobile devices.

Technically, webcasting can be divided into a client and server side. The client application is responsible for capturing and encoding the material. The server side broadcasts the material to all recipients.

The simplest client-side application for simple streaming is just a browser. However, if we want customizable output, we need a specialized application. There is a number of such applications available on the market, such as OBS Studio (<https://obsproject.com>), FFsplit (<https://www.ffmpeg.org/>) or XSplit (<https://www.xsplit.com>), many of which are Open Source or Freeware tools.



Example: *Open Broadcaster Studio (OBS Studio, <https://obsproject.com>)*

OBS Studio is one of the most popular broadcasting applications in the Internet broadcaster community. It is free and open source. Its features include:

- using different data sources: screen capture, camera or static image,
- many possible scene layout definitions (e.g. picture in picture),
- easy switching between layouts,
- scene live broadcasting and scene recording,
- portability (Windows, MacOS, Linux).

After some training, its features are more than enough for several use cases in academia.

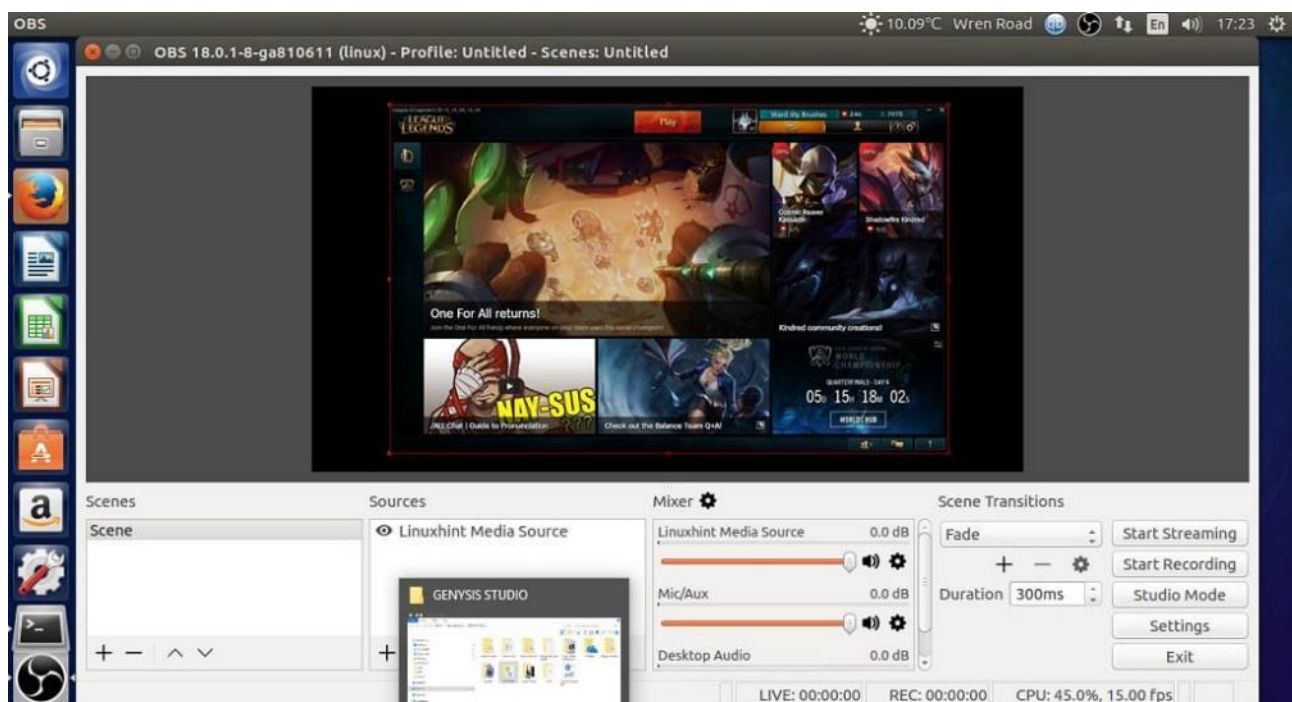


Figure 12 OBS Studio – configuration screen (source: <https://linuxhint.com/install-open-broadcaster-studio-obs-linux/>-)

3.2.1.2 Streaming servers

The most secure way of broadcasting is to establish one's own streaming server to distribute content among different users. One possibility is to simply install NGINX Web Server (<https://nginx.org/en/>) with RTMP module, which is not very complicated under Linux or Windows.

Streaming applications can cooperate with different public streaming servers such as Twitch.tv (<https://www.twitch.tv/>), YouTube (<https://www.youtube.com/>) or Facebook Live (<https://www.facebook.com/>). All public servers offer different levels of content security. Therefore, if we do not wish to make the content available for everybody, we must be careful choosing the right server. E.g. Facebook video stream can be made available to everybody, or one can create a private Facebook group and limit recipients only to this group.

When selecting an appropriate streaming server, the broadcast quality must also be taken into consideration, which is especially important when capturing screen output for the demonstration of some application.

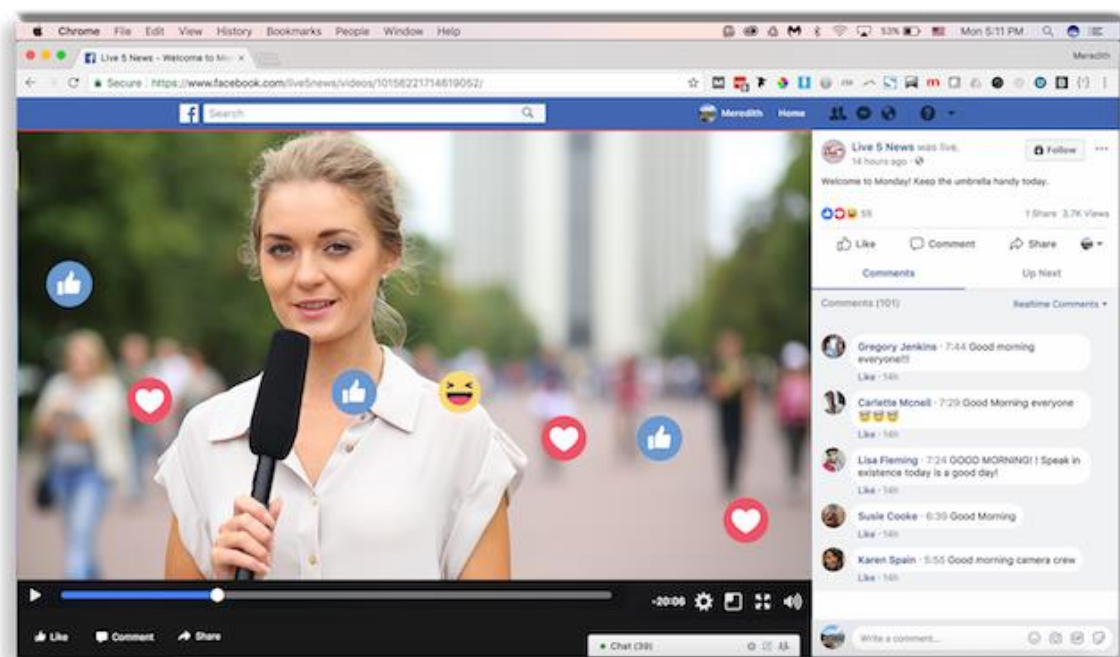


Figure 13 Facebook-live (source: <https://www.wowza.com/blog/facebook-live-tips-for-broadcasters>)





3.2.1.3 Teleconferencing tools

Teleconferencing tools are direct extensions of Internet communication tools. Examples of these tools are e.g. Skype, Google Hangouts or Messenger. Most of these free tools provide basic videoconferencing features, such as multipoint video and audio broadcast between multiple participants. Teleconferencing tools must enable effective two-way communication between all members of the meeting. Not only voice but also image transmission is important to maintain eye-contact, which makes conversation more efficient.

As pointed out by Wikipedia (<https://en.wikipedia.org/wiki/Videotelephony>), the popularization of videoconferencing has already opened multiple new paths of communication. These include:

- the ability to keep in touch with classes during conferences,
- ‘virtual’ participation in conferences, thesis defenses, guest lectures,
- collaboration with other team members without actual physical presence,
- conducting Q&A sessions.

Teleconferencing tools may be used as stand-alone tools, but can also improve the efficiency of other tools, such as Collaborative Design Tools as supportive direct communication components.

Basic free teleconferencing tools such as Skype (<https://www.skype.com/en/>), Google Hangouts (<https://hangouts.google.com/>) or Messenger (<https://www.messenger.com/>) fulfill the needs in most academic situations. However, for large meetings some paid solutions (e.g. EzTalks (<https://www.eztalks.com/>), Bluejeans (<https://pages.bluejeans.com>) or Skype for Business (<https://www.skype.com/en/business/>) may be considered.



3.2.1.4 Webinars

Webinar software is directly related to teleconferencing tools and teleconferencing tools can be used to organize webinars. However, in addition to the effective transmission of audio and video, webinar tools meet some additional expectations:

- the ability to upload a presentation file for interactive presentation (with the possibility of annotating the presentation),
- whiteboard functionality,
- chat functionality for live teacher-student communication,
- desktop sharing features (for demonstrating applications),
- asymmetry between users (teacher has more privileges than students – e.g. she/he may be the only one to use camera or control presentation), but with possibility of role switching,
- some interactive tools (short quizzes, polls),
- the ability to add comments on hosting webinars.

There are multiple free Open Source webinar solutions, e.g. Apache OpenMeetings (<https://openmeetings.apache.org/>) or BigBlueButton (<https://bigbluebutton.org/>) (for full review see: <https://elearningindustry.com/top-6-open-source-web-conferencing-software-tools-elearning-professionals>). Free Webinar tools are free to download but require hosting, which may implicate additional costs. Often plugins are offered to integrate such tools into larger Learning Management Systems platforms.

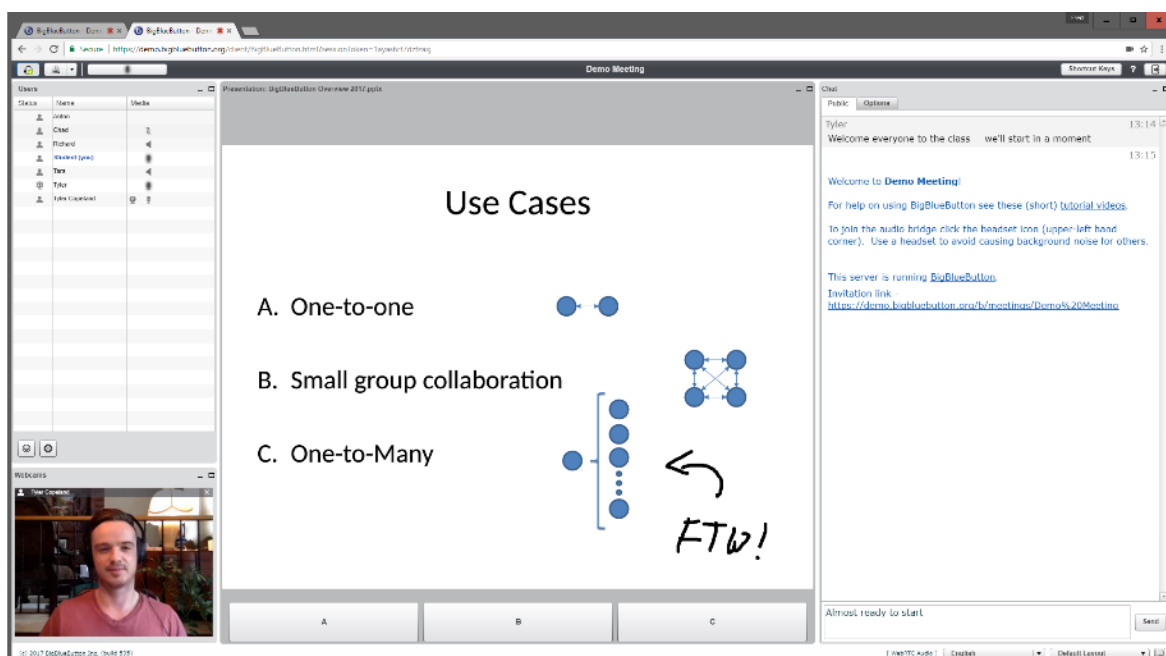


Figure 14 Webinar in progress using BigBlueButton (source: <https://bigbluebutton.org/2017/05/25/bigbluebutton-1-1-released/>)



3.2.2 Creating e-learning materials

This section is split between the creation of educational videos and the authoring of interactive educational content.

3.2.2.1 Creating educational videos

Tools in this category enable teachers to prepare video materials that can be used by students online or offline. The scope of such materials varies. The recording can either be an e-lecture with slides and narration, hand-on demonstration of some application or a mix of different multi-media sources. A useful tool for authoring educational video materials should include at least:

- the utility of simultaneously recording video and audio material from different sources – so it should act as audio/video/screen recorder, all recorded material should be produced in different tracks for efficient editing,
- the utility of editing video and audio simply and efficiently.

There are multiple commercial applications on the market that fulfill these requirements, such as Camtasia (249 EUR, <https://www.techsmith.com/video-editor.html>), Active Presenter (199\$, <https://atomisystems.com/activepresenter/>) or ScreenFlow (129\$, <https://www.telestream.net/screenflow/>). Organizing an effective workflow using only free solutions is possible but requires considerable effort.

Example: *Camtasia* (<https://www.techsmith.com/video-editor.html>)

Camtasia is one of the tools that is readily used for creating e-learning content. Camtasia has many advanced features, yet it is still very easy-to-use and is offered for a moderate price (199\$ - perpetual license).

Some more interesting features of Camtasia include:

- advanced audio editing, including noise reduction and sound-level normalization,
- advanced video effects with bias towards presentation (annotations, customizable transitions, template effects),
- different presets to facilitate and speed-up editing,
- import of different file types (PowerPoint, PDF),
- availability of different effect templates,
- some interaction options included (quizzes) – requires dedicated player.



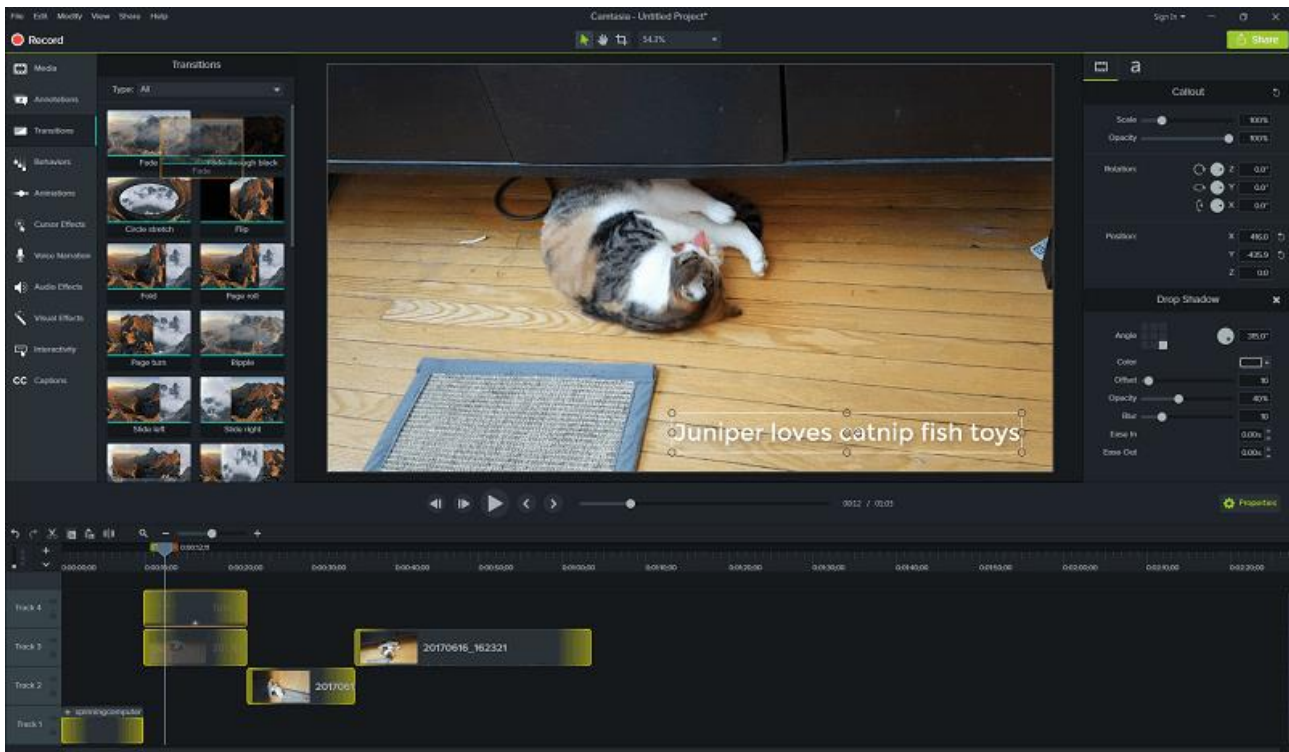


Figure 15 Video editing in Camtasia (source: <https://www.softwarehow.com/camtasia-review/> – last access 30.06.2019)

Example: OBS Studio/KDEnLive/Audacity

It is possible to create basic e-learning videos using completely free and open source applications. In this section we present a simple workflow that uses three non-commercial applications:

- **OBS Studio** (<https://obsproject.com/>) is mainly a webcasting software. However, recording options are also available. The main problem with this software is that it does not support, by default, multitrack synchronized recording (e.g. camera and desktop), so some tricks must be utilized to overcome the problem.
- **Audacity** (<https://www.audacityteam.org/>) is the OpenSource sound processing tool ideal for setting sound levels in recordings and noise removal.
- **KDEnLive** (<https://kdenlive.org>) is a free but powerful movie editing software. It has a large number of features that are known to commercial editors. However, the application is not always stable and the interface is not as intuitive as in the case of its commercial colleagues.

While authoring educational videos by using these tools is possible, one may face a significant decrease in productivity. In the case of incidental preparation of educational videos, the usage of free tools may be justified. If videos are produced on a regular basis, commercial applications should be considered.



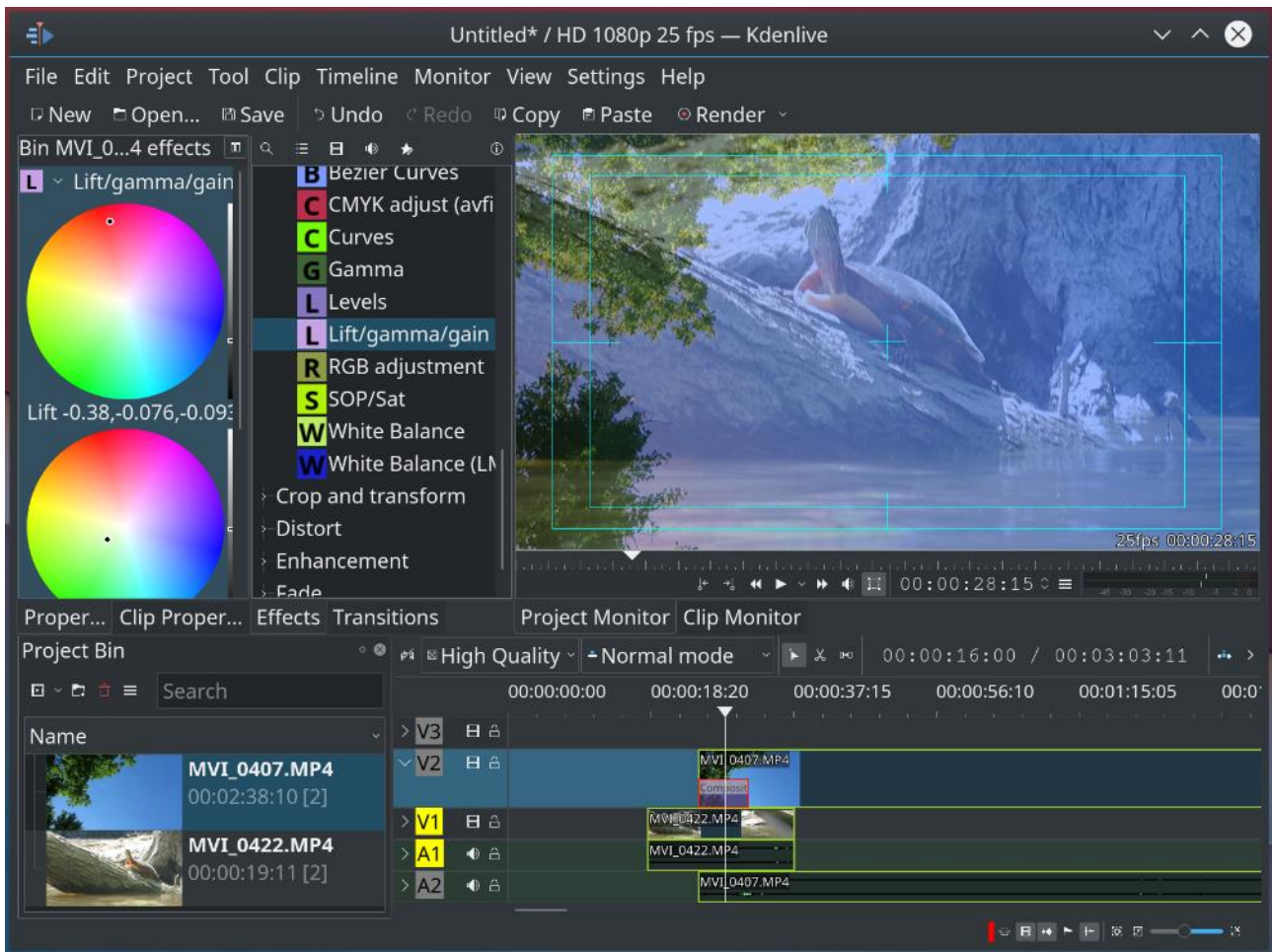


Figure 16 Kdenlive video editor (source: <https://kdenlive.org/en/2018/07/kdenlive-test-the-future/>)



3.2.2.2 Authoring interactive educational content

The tools within this category typically have very strong video and audio capture and editing features, but they go one (or several) steps further. The goal of these tools is to create stand-alone interactive educational content, that in addition to text, images, sound, and video, also have an interaction component. This material is responsive to user interaction, so e.g. the presentation can branch out in many directions depending on user choices. Typically, it is also possible to include various games or quizzes to immediately assess and evaluate the understanding of the material.

The main application of this kind of tools is the creation of a single educational unit (a single class, a single training session or tutorial). Prepared interactive presentation can be exported to a SCORM unit (<https://www.adlnet.gov/scorm/>) and integrated into a selected Learning Management System, to make a regular course.

These kind of authoring tools are advanced and quite expensive. Some commonly used software packages include Adobe Captivate (retail price 1597.77 EUR, student/teacher price 490.77 EUR, <https://www.adobe.com/pl/products/captivate.html>) or ISpring Suite (770\$, <https://www.ispringsolutions.com/ispring-suite>).

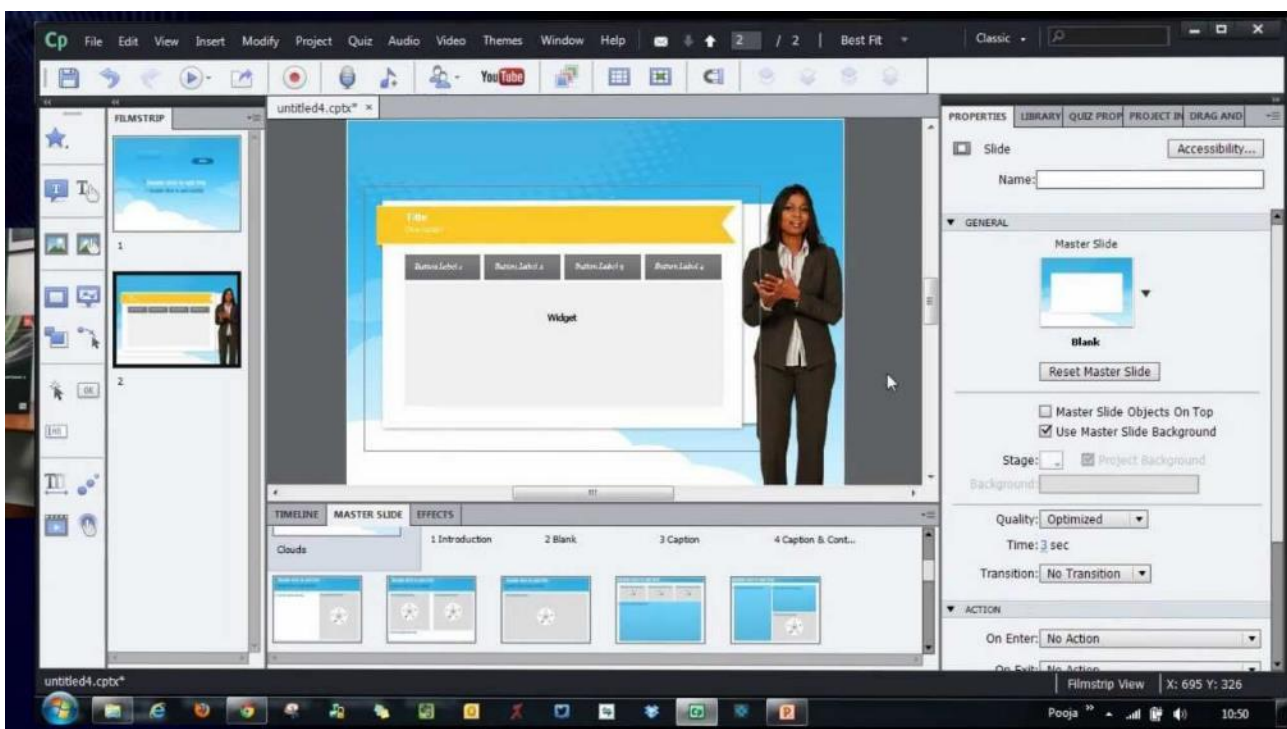


Figure 17 Adobe Captivate (source: <https://www.youtube.com/watch?v=laC6Brkfy4> – last access 30.06.2019)



3.2.3 Learning Management Systems (LMS)

Learning Management Systems (LMS) are systems that gather all the electronic educational content. Their main responsibility is to convert a collection of different e-learning materials into an organized course that can be provided to students. However, larger entities can also be carried out using this kind of systems. There is still a growing number of university programs completely held in LMS.

Features of a useful LMS include (but are not limited to):

- organizing different types of learning materials (e.g. videos, interactive presentations, quizzes, tasks) into a course and/or educational program,
- setting the pace for each course (defining separate lessons, chapters),
- keeping record of student's progress, achievements and grades,
- providing tools for educational data presentation:
 - lesson editors including text, embedded videos and other multi-media materials,
 - tools for administering quizzes, tests and examinations,
 - tools for giving out, managing and collecting assignments.
- integration with other types of educational content and applications via a system of plugins including e.g.
 - Webinar software,
 - SCORM packages (self-contained ZIP file containing certain contents defined by the SCORM standard, see <http://www.scormsoft.com/scorm/cam/contentPackages/>),
 - auto-evaluated tasks (e.g. automatic verification of programming assignments).

There are many LMS systems tools available. However, currently the market is more or less evenly shared between 3 main players: Blackboard (<https://www.blackboard.com/blackboard-learn/>), Canvas (<https://www.canvaslms.com/open-source-lms>) and Moodle (<https://moodle.org/>), and a smaller share for Brightspace (<https://www.d2l.com/en-eu/>). All of them except Moodle are commercial applications.



Example: Moodle (<https://moodle.org/>)

Moodle is the main free player on the market of free and open source LMS solutions. While not being very easy for setting-up, administration and use, it holds most of the features expected from this kind of tools, and all for free. Moodle is an open system and can be supplemented by a large number of plugins to extend the basic functionality of the system.

Moodle is a web service and is typically installed on a hosted web server. So, although Moodle itself is free, one must still add hosting fees to the total cost of installation and deployment.

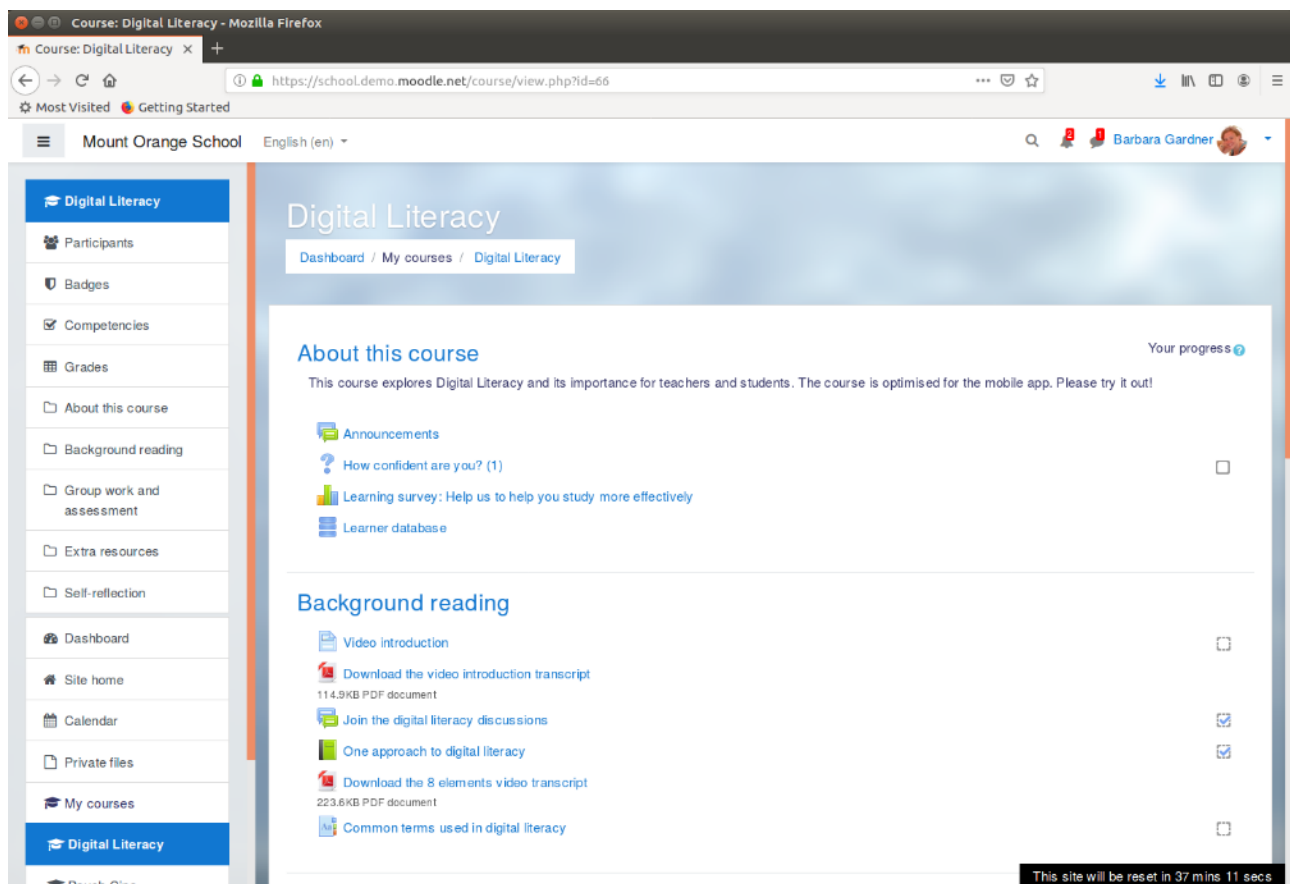


Figure 18 Moodle (source: [OBJ] last access 30.06.2019)





3.3 Online learning

2020 brought unexpected political, organizational, and social changes. The organization of work, teaching and interpersonal relations has changed dramatically. What previously seemed impossible, or at least like a lengthy process, underwent a significant remodeling within a few weeks. This was also the case with online learning.

We can roughly divide online learning into several sections: lectures, workshops, laboratories, project classes, seminars. Each of them has slightly different organizational and tool requirements.

As you plan the objectives and activities for your online session, it may be helpful to keep the following priorities in mind when selecting digital tools and platforms:

- **Communicate in real time.** Being able to see everyone's face, hear their voice during the workshop and create spaces to express yourself in chat. Create spaces and times so that participants can meet in large groups and in small groups.
- **Share content.** This may mean sharing your presentation, documents, or your screen:
 - **during the session** to support the teaching process,
 - **before the session** for the preparation of students for classes, e.g. in the case of flipped classes,
 - **after the session** to keep students interested.
- **Think visually.** Having visual tools (e.g. boards) can help capture and exchange ideas, interact, co-create and keep the focus of the conversation.
- **Take notes and generate outputs.** Take advantage of the digital dimension of the session and capture data and information in an agile way.
- **Maintain the organization of work.** If the group plans to work together for a while, you may need to keep track of tasks, resources, events, and decisions.

Selected platforms to host online sessions are listed below.



Example: Zoom (<https://zoom.us/>)

Zoom is a popular online meeting and teaching tool. The free version provides a video chat service that allows you to use up to 100 devices simultaneously, with a 40-minute time limit for free accounts that host meetings of three or more participants. Users have the option to upgrade by subscribing to one of its paid plans – the highest one allows for simultaneous service of up to 1000 people, without time limits. It allows you to conveniently create student subgroups during classes, has both group and individual chat, allows you to share documents and the screen by each participant of the meeting.



Figure 19 Zoom (source: last access 09.03.2021)

Example: Microsoft Teams (<https://www.microsoft.com/en-us/microsoft-365/microsoft-teams/group-chat-software>)

It is a complex environment for organizing online meetings, formulating tasks and schedules. It has an integrated chat and it is connected to a cloud service that allows you to post materials. It is integrated with the calendar and mail services. Like other tools, it allows you to organize subgroups within the meetings and to plan regular meetings. It is integrated with other Microsoft tools, e.g. office forms, used to check knowledge online. It allows each participant in the meeting to share documents and the screen.



Figure 20 Microsoft Teams (source: last access 09.03.2021)

Example: Google Meet (<https://meet.google.com/>)

Google Meet is a tool for organizing online meetings. It is integrated with Google Cloud services and it allows you, among other things, to share Google documents, conduct tests, tests using form tools, and to connect with the Google calendar, in addition to planning regular meetings.

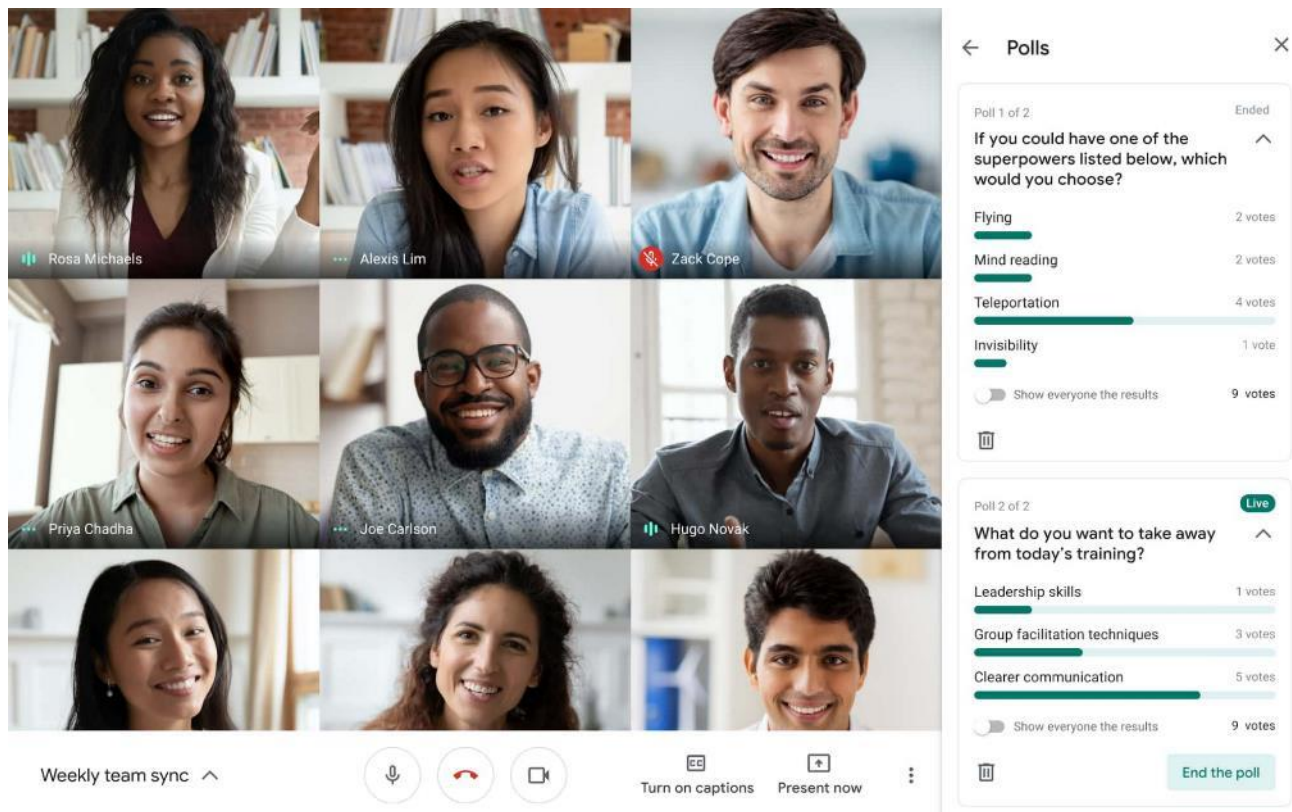


Figure 21 Google Meet (source: <https://cloud.google.com/blog/products/google-meet/introducing-ga-and-polls-in-google-meet> last access 09.03.2021)

Other tools are listed below:

- GoToTraining <https://www.gotomeeting.com/es-es/training>,
- GoToWebinar <https://www.gotomeeting.com/es-es/webinar>,
- Adobe Connect <https://www.adobe.com/products/adobeconnect.html>,
- BlackBoard <https://www.blackboard.com/>,
- Webex.Meetings from CISCO <https://www.webex.com/>.



Summary

4 Summary

An important observation to take from the review given in this document is that there are plenty of options to choose from regarding tools that serve particular educational needs. The tools are still evolving. New features are added, and new players appear on the market each year. Therefore, with respect to the selection of particular applications, this review should not be treated as an ultimate recipe but rather as a starting point for research among the available tools and encouragement for one's own evaluation and selection of the tools that are most suitable for the particular needs of an educational institution.



References



5 References

5.1 Bibliography

Chen B., Wan J., Shu L., Li P., Mukherjee M., Yin B., 2017, Smart Factory of Industry 4.0: Key Technologies, Application Case, and Challenges, *IEEE Access*, vol. 6, pp. 6505 - 6519. DOI: 10.1109/ACCESS.2017.2783682

Filho M.F., Liao Y., Loures E.R., Canciglieri O., 2017, Self-Aware Smart Products: Systematic Literature Review, Conceptual Design and Prototype Implementation. *Procedia Manufacturing*, vol. 11, pp. 1471-1480. DOI:10.1016/J.PROMFG.2017.07.278

Hofmann E., Ruesch M., 2017, Industry 4.0 and the current status as well as future prospects on logistics, *Computers in Industry*, vol. 89, pp. 23-34. DOI:10.1016/j.compind.2017.04.002

Kagermann H., Lukas W.-D., Wahlster W., 2011, Industrie 4.0: Mit dem Internet der Dinge auf dem Weg zur 4. industriellen Revolution, *VDI Nachrichten*, vol. 13, pp. 3-4. DOI:10.13140/RG.2.1.1205.8966

McQuaid R.W., Lindsay C., 2005, The concept of employability. *Urban Studies*, vol. 42, is. 2, pp. 197-219. DOI:10.1080/0042098042000316100

Passow H.J., Passow C.H., 2017, What Competencies Should Undergraduate Engineering Programs Emphasize? A Systematic Review. *Journal of Engineering Education*, vol. 106, is. 3, pp. 475-526. DOI:10.1002/jee.20171



5.2 Netography

Review of Cloud Storage Solutions, <https://www.cloudwards.net/comparison/>, on-line accessed: 2019.06.23

Google drive, <https://www.cnet.com/how-to/hidden-features-of-google-drive/>, on-line accessed: 2019.06.26

Comparison of document collaboration tools, <https://blog.bit.ai/document-collaboration-tools/>, on-line accessed: 2019.06.26

MS Word Online, <https://products.office.com/pl-pl/office-online/documents-spreadsheets-presentations-office-online>, on-line accessed: 2019.06.28

DokuWiki, <https://www.dokuwiki.org/template:starter>, on-line accessed: 2019.06.28

Best Kanban tools of 2019, <https://thedigitalprojectmanager.com/best-trello-alternatives-top-kanban-tools/>, on-line accessed: 2019.06.28

Trello vs. Asana, <https://www.process.st/trello-vs-asana/>, on-line accessed: 2019.06.28

Lean tools for teams, <https://getheroik.com/lean-tools-that-will-take-your-team-to-the-next-level/slack-screenshot/>, on-line accessed: 2019.06.28

Asana, <https://asana.com/product,on-line>, on-line accessed: 2019.06.30

GetApp-Redmine, <https://www.getapp.com/project-management-planning-software/a/redmine/>, on-line accessed: 2019.06.30

Getting into remote DT with Mural, <https://blog.mural.co/2015/12/15/getting-into-remote-design-thinking-with-mural>, on-line accessed: 2019.06.30

Mural.ly, <https://mural.co/>, on-line accessed: 2019.06.30

Linux-hint, OBS Studio <https://linuxhint.com/install-open-broadcaster-studio-obs-linux/>, on-line accessed: 2019.06.30

Facebook Live Stream Tips&Tactics, <https://www.wowza.com/blog/facebook-live-tips-for-broadcasters>, on-line accessed: 2019.06.30

Wikipedia-Videotelephony, <https://en.wikipedia.org/wiki/Videotelephony>, on-line accessed: 2019.07.01

Top 6 Open Source Web Conferencing Software, <https://elearningindustry.com/top-6-open-source-web-conferencing-software-tools-elearning-professionals>, on-line accessed: 2019.07.01

BigBlueButton 1.1 Released, <https://bigbluebutton.org/2017/05/25/bigbluebutton-1-1-released/>, on-line accessed 2019.07.01





SoftwareHow-Camtasia Review, <https://www.softwarehow.com/camtasia-review/>, on-line accessed: 2019.07.01

Kdenlive, <https://kdenlive.org/en/2018/07/kdenlive-test-the-future/>, on-line accessed: 2019.07.01

YouTube-Adobe Captivate, <https://www.youtube.com/watch?v=laC6Brkfmy4>, on-line accessed: 2019.07.01

Moodle School Demo, <https://school.demo.moodle.net>, on-line accessed: 2019.07.01

MS OneDrive, <https://onedrive.live.com>, on-line accessed: 2019.07.01

Google Drive, <https://drive.google.com>, on-line accessed: 2019.07.01

DropBox, <https://www.dropbox.com>, on-line accessed: 2019.07.01

MEGA.nz, <https://mega.nz/>, on-line accessed: 2019.07.01

Google Docs, <https://docs.google.com/>, on-line accessed: 2019.07.01

MS Office Online, <https://office.live.com>, on-line accessed: 2019.07.01

BIT.ai, <https://bit.ai/>, on-line accessed: 2019.07.01

Atlassian Confluence, <https://www.atlassian.com/software/confluence>, on-line accessed: 2019.07.01

UseModWiki, <http://www.usemod.com/cgi-bin/wiki.pl>, on-line accessed: 2019.07.02

MediaWiki, <https://www.mediawiki.org/wiki/MediaWiki>, on-line accessed: 2019.07.02

DokuWiki, <https://www.dokuwiki.org/dokuwiki>, on-line accessed: 2019.07.02

Trello, <https://trello.com/>, on-line accessed: 2019.07.02

Clarizen Go, <https://go.clarizen.com/>, on-line accessed: 2019.07.02

Paymo, <https://www.paymoapp.com>, on-line accessed: 2019.07.02

Kanbanize, <https://kanbanize.com>, on-line accessed: 2019.07.02

Monday.com, <https://monday.com/>, on-line accessed: 2019.07.02

Slack, <https://slack.com>, on-line accessed: 2019.07.02

Asana, <https://asana.com/>, on-line accessed: 2019.07.02

Basecamp, <https://basecamp.com/>, on-line accessed: 2019.07.02

Casual, <https://casual.pm/>, on-line accessed: 2019.07.02





Teamweek, <https://teamweek.com/>, on-line accessed: 2019.07.02

Redmine, <https://www.redmine.org/>, on-line accessed: 2019.07.02

MURAL, <https://mural.ly>, on-line accessed: 2019.07.02

Miro, (formerly *RealTimeBoard*), <https://miro.com/>, on-line accessed: 2019.07.02

Spacedeck (Open Souce license), <https://github.com/spacedeck/spacedeck-open>, on-line accessed: 2019.07.02

Lucidchart, <https://www.lucidchart.com>, on-line accessed: 2019.07.02

Sketchboard.io, <https://sketchboard.io/>, on-line accessed: 2019.07.02

OBS Studio, <https://obsproject.com>, on-line accessed: 2019.07.02

FFsplit, <https://www.ffsplit.com/>, on-line accessed: 2019.07.02

XSplit, <https://www.xsplit.com>, on-line accessed: 2019.07.02

NGINX Web Server, <https://nginx.org/en/>, on-line accessed: 2019.07.02

Twitch.tv, <https://www.twitch.tv/>, on-line accessed: 2019.07.02

YouTube, <https://www.youtube.com/>, on-line accessed: 2019.07.02

Facebook Live, <https://www.facebook.com/>, on-line accessed: 2019.07.02

Apache OpenMeetings, <https://openmeetings.apache.org/>, on-line accessed: 2019.07.02

BigBlueButton, <https://bigbluebutton.org/>, on-line accessed: 2019.07.02

Camtasia, <https://www.techsmith.com/video-editor.html>, on-line accessed: 2019.07.02

Active Presenter, <https://atomisystems.com/activepresenter/>, on-line accessed: 2019.07.02

ScreenFlow, <https://www.telestream.net/screenflow/>, on-line accessed: 2019.07.02

OBS Studio, <https://obsproject.com>, on-line accessed: 2019.07.02

Audacity, <https://www.audacityteam.org/>, on-line accessed: 2019.07.02

KDEnLive, <https://kdenlive.org>, on-line accessed: 2019.07.02

The Advanced Distributed Learning Initiative, <https://www.adlnet.gov/scorm/>, on-line accessed: 2019.07.02

Adobe Captivate, <https://www.adobe.com/pl/products/captivate.html>, on-line accessed: 2019.07.02

ISpring Suite, <https://www.ispringsolutions.com/ispring-suite>, on-line accessed: 2019.07.02





Blackboard, <https://www.blackboard.com/blackboard-learn/>, on-line accessed: 2019.07.02

Canvas, <https://www.canvaslms.com/open-source-lms>, on-line accessed: 2019.07.02

Moodle, <https://moodle.org/>, on-line accessed: 2019.07.02

Brightspace, <https://www.d2l.com/en-eu/>, on-line accessed: 2019.07.02

OKNO PW, <http://okno.pw.edu.pl/>, on-line accessed: 2019.07.03

Coursera, <https://www.coursera.org/>, on-line accessed: 2019.07.03

EdX, <https://www.edx.org/>, on-line accessed: 2019.07.03

Skype, <https://www.skype.com/en/>, on-line accessed: 2019.07.03

Google Hangouts, <https://hangouts.google.com/>, on-line accessed: 2019.07.03

Messenger, <https://www.messenger.com/>, on-line accessed: 2019.07.03

EzTalks, <https://www.eztalks.com/>, on-line accessed: 2019.07.03

Bluejeans, <https://pages.bluejeans.com>, on-line accessed: 2019.07.03

Skype for Business, <https://www.skype.com/en/business/>, on-line accessed: 2019.07.03





Co-funded by the
Erasmus+ Programme
of the European Union



Universities of the Future is a Knowledge Alliance Project (588409-EPP-1-2017-1-PT-EPPKA2-KA). This project has been funded with the support of the European Commission. This website reflects the views only of the author, and the Commission cannot be held responsible for any use which may be made of the information contained therein.