UNIVERSITIES OF THE FUTURE

COLLABORATIVE DIGITAL SHIFT TOWARDS A NEW FRAMEWORK FOR INDUSTRY AND EDUCATION

Toolkit for teachers

Tools & methods

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Introduction and foreword

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1 Introduction and foreword

This toolkit for teachers includes a set of elementary learning tools that can be used for up-skilling and re-skilling students and workforce, regarding Industry 4.0, but not limited to this subject area. In addition, several innovative group-centered learning methodologies, that support T-shape and co-creation education, are proposed.

According to Jensen and Keogh (2017), the inspiration for co-creation in education came from the business world, where the concept was introduced by Prahalad and Ramaswamy (2000). The authors stated that users (consumers, customers) are often omitted as the factor having the most radical impact on industrial systems, but they are often treated as passive recipients, instead of engaging them in co-creation. As active participants, they co-create and develop products and services. Prahalad and Ramaswamy (2000) argued that „by doing this, customers are fundamentally changing the dynamics of the marketplace, with marketplaces becoming forums where the consumers play an active role in establishing values" (Jensen and Keogh, 2017). Paraphrasing the statement of Vargo et al. (2008), value co-creation transparency and access also help the process of allowing for more balanced roles between universities and students. Let us replace „customers" with „students" and let us treat „university" as a „marketplace". The students, the teachers, others representing HEIs, the entrepreneurs, and people in the public sector, have to take active parts in the education process, they have to co-create it, as their conscious and open contribution is important for value setting in the educational process.

The content of the toolkit for teachers (tools and methodologies) consists of or is associated with:

- best practices connected to methods of education developed on the basis of interviews with professors, teachers, students and industry representatives involved in higher education processes – almost 200 potential cases were analyzed which resulted in the 35 benchmarks ranking – the results are published as Benchmarking report (2018),
- description of the training courses – developed on the basis of training courses (Platoniq, 2018a, Platoniq, 2018b), which were held during the Train the Trainers event and which resulted in the creation of internal methodological framework for the development of innovative solutions to the challenges of Education 4.0 (the documentation provides tools for the training in valuable skills for students and workers who want to develop the collaborative mindset and skills required to thrive in Industry 4.0 and are discussed in this toolkit)
- analyses of educative assets,
- description of other elementary methods of education,
- selection and description of innovative group-centered learning methodologies that support both T-shape (defined in subsection 2.3.2.) and co-creation education (defined in subsection 3.3. and their fusion (the mentioned terms are described in this toolkit).

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Current situation

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2 Current situations

2.1 Industry 4.0: state of affairs

The first reference to Industry 4.0 was introduced at the Hannover Fair of Industrial Technologies in 2011 (Barreto et al., 2017; Bartevyan, 2015). The launch of Industry 4.0 is caused by on one hand the rapid development of technology, and on the other hand by social and economic factors. Key technologies which propel Industry 4.0 are augmented reality, simulation, autonomous vehicles and robots, additive manufacturing, industrial robotics, mechanical arms, machining centers, distributed ledger systems (e.g. blockchain), big data analytics, Industrial Wireless Sensor Networks, mobile computing, and cloud computing, edge computing, multi-agent systems, 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). These technologies affect and enable the creation of different novel business models (State-of-Maturity Report, 2019).

In the case of Industry 4.0, technology is not the only driving force. Another crucial group of factors, supportive for the technical aspects, are social and economic factors such as telecommuting, emerging platform economies, increase of freelancing, consultant-style services, and etc. (State-of-Maturity Report, 2019). At the same time, more and more people are getting used to a new, flexible type of work, but it also means that interpersonal relationships at work environments are becoming more and more interdependent (Hofmann and Ruesch 2017). Industry 4.0 impacts business models as well. These are becoming more network-oriented, unlike currently used traditional vertical orientation (Ibarra et al., 2018). As industrialization changes the economy from capital-intensive to knowledge-based, networks enable better cooperation for the creation and exchange of knowledge (Qin et al., 2016, State-of-Maturity Report, 2019).

There are plenty of factors connected to Industry 4.0 which might be taken under dispute, however these factors could become the starting point for the application of proposed methodologies and tools during courses at universities. These factors include climate change and natural resources, geopolitical volatility, consumers and privacy issues, young demographics in emerging markets, women's economic power, and rapid urbanization (Filho, 2017, State-of-Maturity Report, 2019).

2.2 Post COVID-19 learning situation

The year 2020 challenges us to bet on the dynamization of virtual spaces. If digital tools have, for years, 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 educate, host debates, co-create projects, and get organized. The pandemic situation is forcing teachers around the world to drastically change the way they teach. Tools that were previously less used have been rapidly developed and adapted. We will certainly not return to the situation that was present before 2020, and the methods that have emerged will evolve in the years to come. That is why we describe in this material a categorization of methods of education from the point of view of meetings organization.
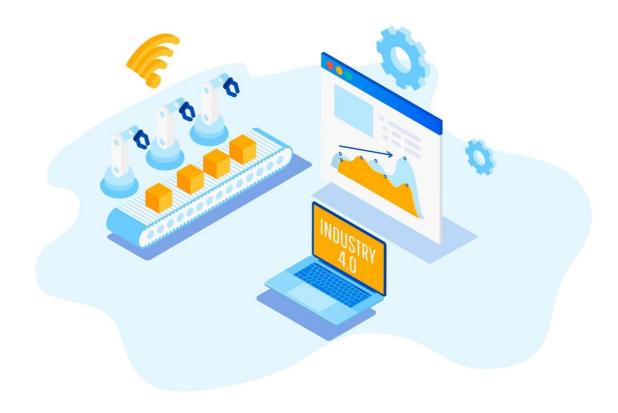
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2.3 Trends

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

The future trends and related challenges to implementation of Industry 4.0 were presented based on the previously conducted interviews and identified national or grassroots initiatives. The future trends and related challenges were grouped in the following areas:

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

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

2.4 Skills to teach and acquire and acts of throughout life acquiring new skills

Based on several studies, benchmarks (Benchmarking report, 2018), and events connected to the Universities of the Future project, the most important up-to-date skills and attitudes to teach or/and acquire were identified. These are briefly described in the following sections.

2.4.1 Lifelong learning

Enterprises reported a need to raise or change the qualifications of their employees, which is dictated by a change in technologies or production processes. Moreover, companies remark that there is a need for continuous improvement and learning (Life-long Learning) among their employees. On the other hand, the graduates who then become employees, claim that they have been taught and made aware of the need to learn throughout their lives. After all, Lifelong Learning is the act of acquiring new skills throughout life. In contrast, there is not a rooted lifelong learning culture at universities, were young people are taught about the need to learn throughout their life. Often, no one teaches how to learn (Benchmarking report, 2018).

2.4.2 T-shape skills

T-shape skills are understood as follows: the vertical bar on the letter *T* represents the depth of skills and expertise related to a single knowledge discipline or its part, whereas the horizontal bar is the ability to collaborate across various disciplines with experts in other areas and to apply knowledge in areas of expertise other than one's own (Szulczewska-Remi and Foltynowicz, 2016, Wikipedia, 2016). The 'T-shaped' phrase was popularized by Tim Brown, CEO of design and innovation company IDEO (Brown, 2009).

2.4.3 Cross-cultural learning

Cross-cultural learning is understood as a learning process in which an important element is the student's adaptation to the new environment and its requirements by obtaining the necessary knowledge, skills and attitudes (Hannigan, 1990). According to the definition of Bartel-Radic (2006), intercultural learning is "acquiring or modifying the representation of intercultural situations".

2.4.4 Working life skills

Skills (referred to as working life skills in State-of-Maturity Report, 2019) in general are divided into discipline-specific skills and transferable skills (non-discipline specific skills). The second one is divided into problem-solving skills, system thinking, business thinking, social and interpersonal skills, and technological literacy. Problem-solving skills and interpersonal skills are altogether called soft skills (Bridges, 1993). According to McMurray et al. (2016), the most important transferable skills for employers when recruiting graduates are trustworthiness, reliability, motivation, communication skills, and a willingness to learn.

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2.4.4.1 Problem-solving skills

Problem-solving skills are transferable skills essential for work in Industry 4.0, as professional work is continuously based on problem-solving (State-of-Maturity Report, 2019). Three aspects connected to problem-solving were identified by Schein (1972): the basic science component, the applied science for problem-solving, and the skills and attitudes used for solving the problem (the most important from the point of view of this toolkit).

Problem solving includes the processes of observation, identification, reflection, formulation or framing of a problem, and experimentation with creativity as factors supporting the thinking process. These processes are also a part of the general scientific process according to Schön (1983), and Passow and Passow (2017). It is important to add the analysis and interpretation of data and information to this process. These pair can be understood as working life skills and at the same time as components of the problem-solving process as well (Passow and Passow 2017, Rautavaara 2015).

2.4.4.2 Systems thinking

Systems thinking is a holistic approach to analysis that focuses on the way that a system's constituent parts interrelate and how systems work overtime and within the context of larger systems. The systems thinking approach contrasts with traditional analysis, which studies systems by breaking them down into their separate elements. Systems thinking can be used in any area of research and has been applied to the study of medical, environmental, political, economic, human resources, and educational systems, among many others (Rouse, 2005).

Systems thinking refers to the ability to understand things in a larger context, their impact, and possible applications and implications, Senge (1990). The professional working environment makes people struggle with the complex dilemmas in every day life. They need to understand the consequences of their decisions, not only as they affect the company, but also their impact on a larger scale – on society, environment, etc. (State-of-Maturity Report, 2019). Knowledge on ethics, social responsibility, and sustainability can be useful tools that help people make better decisions. Moreover, Morrar et al. (2017) address the issue of social innovation in the Industry 4.0 context, acknowledging the importance of understanding the greater impact of technology on society, and the need for these issues to be addressed from the point of view of the different stakeholders (State-of-Maturity Report, 2019).

2.4.4.3 Business thinking

Commercial awareness is treated as a skill that impacts employability (Hillage and Pollard 1998, McQuaid and Lindsay 2005) and referred to business thinking. It is defined as a general understanding of basic business concepts and the ability to comprehend aproduct or service's commercial value. Business thinking is classified as a transferable skill due to the fact that a business degree is not required to develop some commercial awareness (State-of-Maturity Report, 2019). More business-specific knowledge and competencies are discussed in State-of-Maturity Report (2019).

2.4.4.4 Technological literacy

The simplest definition of technological literacy is the knowledge or familiarity with modern engineering tools, according to McQuaid and Lindsay (2005). Dakers (2006) while defining the term of technological literacy referred to the language necessary to talk about technology itself (mostly, aspects of technology tools) and technology education (mostly, aspects of knowledge).

2.4.4.5 Social and interpersonal skills

Social and interpersonal skills, referred to as soft skills, are another identified component of professional work. Soft skills enable people to work and learn with and from each other (State-of-Maturity Report, 2019). The technical universities (e.g. Warsaw University of Technology) have deficiencies in the teaching of soft skills, it can result from a lack of knowledge about the need to teach these skills, lack of skills about the ways of teaching them. University staff also often lack the motivation to develop their own learning tools and methods, as it is often work, they are not compensated for or evaluated on (Benchmarking report, 2018).

Soft skills include: the ability to work in teams, particularly in multidisciplinary teams, leadership, networking and social skills, as well as different types of communication skills (written communication, oral communication, negotiation, persuasion and presentation skills, and assertiveness) (McQuaid and Lindsay, 2005, State-of-Maturity Report, 2019).

In addition to social and interpersonal skills, the following are pointed out as skills important for employability and career management: awareness as metacognitive knowledge (Hillage and Pollard 1998 – Passow and Passow 2017, Pintrich 2002), the personal attributes of will, motivation, self-direction, self-regulation, self-judgement, self-awareness, self-regulation (McQuaid and Lindsay 2005, Pintrich 2002, Weinstein and Meyer 1994, Cornford 2002, Cornford 1999), self-confidence, self-management, responsibility, self-motivation, and recognition for lifelong learning, (Rautavaara 2015). As it was given in State-of-Maturity Report (2019). All of these personal skills and attitudes can also be considered as soft skills. These attributes form the basis of metacognitive skills, including the personal attitudes required for learning-to-learn skills and life-long learning (Rautavaara 2015, Cornford 2002, Cornford 1999). Metacognitive skills and knowledge are not situation-specific, as they can be used in a variety of situations and contexts, for example in problem solving.

2.4.4.5.1 Teamwork

There is a lack of teamwork, both within universities and enterprises. The lack of ability to work in interdisciplinary teams has been reported, and it can be considered as a general lack of cooperation skills, as well as, in enterprises, a lack of collaboration between departments (Benchmarking report, 2018).

2.4.4.5.2 Communication

In turn, industry representatives reported the need to improve communication within the company as well as to improve the flow of information within the organization, specially the company's strategy across the whole organization. Another symptom is the lack, or rather, stopping the learning within the organization. This is extremely interesting because students report that they start work during their studies to learn practical skills (Benchmarking report, 2018).

Class organization

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3 Class organization

3.1 On-line or on-site

In this chapter we summarize the most popular and obvious meeting organizations.

3.1.1 On-site

This is the traditional form of teaching lessons, lectures, laboratories, etc. Teacher and students meet in one place at the same time. This organization has many advantages – first, the possibility to fully participate in the classes, with full contact with the teacher and students. The disadvantage is that it is difficult to organize meetings for spatially dispersed people.

3.1.2 Online

Online teaching allows for fully virtual meetings in virtual classrooms. The teacher and students join the meeting using the online meeting tool (see Toolkit for teachers: technologies). With the use of tools such as: virtual board, on-line documents, and meeting rooms, teachers can organize many forms of teamwork. However, the problems with using this form of meetings are the possibility of students getting distracted, and consequently, incomplete participation in the classes; problems with the Internet connection; and the inability to identify the decrease in interest by the teacher. On the other hand, the online meetings format allows students from all over the world to joined, regardless of location. This creates great opportunities for the so-called virtual mobility, where students can participate in classes at one university without being physically present.

3.1.3 Hybrid

The hybrid form is a combination of on-site and online education. A typical meeting organization is for the teacher and part of the class to be present in one location and the activities are also available on the online meeting tool. This makes it possible for students to participate online. This form requires teachers to divide their attention between being physically present and being online, which is a challenge. In addition, some discipline is also required of them, as they are partially restricted in their mobility. It is also possible to organize such meetings in a slightly less common way, where the students (or some of them) meet physically (possibly in different locations) while the teacher joins the online meeting. This results in easier organization of work for the teacher, but it causes a shift towards fully online education.

3.1.4 Hybrid flexible

The hybrid-flexible form assumes the same organization of meetings as in the hybrid organization, but it is additionally assumed that the students can freely change the organization of their meetings – they can participate physically in some classes, and online in others. It is also possible that a similar organization of meetings may characterize the teacher. With additional assumptions, students can

be required to be physically present at a certain number of meetings, or a presence schedule can be set for them. Of course, these details are up to the class organizer.

3.2 Common fears in online teaching

Teachers want their sessions to be perfect and they face some insecurities or fears. The most common are:

- There is no participation in the class, or there is passivity among the attendees.
- The spaces and sessions are not comfortable for the participants, and there are differences in levels of participation, or some students are excluded.
- The class is boring, or student's needs are neglected.
- There are technical failures.
- The teacher cannot control all the unforeseen cases.

3.3 Suggestions for online teaching

3.3.1 More inclusive digital participation spaces

Facilitating online participation spaces has several differences compared to facilitating face-to-face settings. Among these, one of the issues to consider is the possibility for the participants to feel comfortable to participate and safe enough to express themselves and share their points of view. The way a person understands a safe (or safe enough) space is as variable as the human experience: what may be perceived as safe for someone, may not be for someone else with a different life experience, and vice versa. This has a lot to do with the social, relational, and personal power of people, and how these are managed by the group itself.

If in the face-to-face participation spaces the students can work together on a practical and emotional level to support the collective creation of fairer dynamics that do not harm the participants, working on these issues in digital sessions can be a challenge. In these months, the whole world is processing and elaborating the consequences of the digitization of teaching, of collaboration, of collective life (with the pandemic but not only) and surely this will include reflections on how to support the creation of more comfortable and secure online spaces..

We are people and not machines! It is possible that often, in the search of a perfect workshop or the productivity of the processes, we forget that the human needs that we have as facilitators or participants within an online space can have different nuances in face-to-face spaces. Among these:

- Take **breaks** more frequently than you would in person: physical and eye fatigue caused by the screen affects us a lot! It is also important to take breaks to stretch the neck, legs, and body. Breaks are also important to allow the participants' attention to hold for longer and remain more focused.
- One of the things lost when going from a face-to-face session to a digital one is the **casual conversations**, the affinities, the jokes. For this reason, we try to create presentation round

moments or mini-group moments for participants to develop more confidence and share more.

- Including a **round of introductions** at the beginning of the classes (in medium and small groups) is also useful for the facilitator to know the profiles of the participants. This moment can be useful for groups that intend to work together for a certain period of time, in order to jointly establish what kind of needs must be met for the participants to feel comfortable.

- In your **facilitating**, remember that the ability to offer faster responses by some participants sometimes means that others have not had the space or time to reflect and speak or enough confidence to express themselves. Try not to always give the floor to the people who speak first or not necessarily formulate the activities or questions around correct / incorrect answers that can cause embarrassment. Asking open-ended questions helps people express themselves.

3.3.2 Balanced participation

One of the responsibilities of the teacher is to try to balance the participation of all the students, to be aware of the energies of the group, and to be aware if oppressive dynamics are generated. The virtual dimension challenges us in this: the perceptual channels that we can activate are reduced to a one-dimensional level. Here we leave you some reflections so that we can try to balance participation as much as possible even if we cannot share a physical space.

- **Sharing with the attendees the responsibility that everyone participates** and that some do not silence others helps the whole group to achieve this goal. To do this, don't forget to mention this shared task and ask the whole group for help. If you want, you can think of creating specific roles among the participants, for example someone who is a "thermometer" of energy and that people take turns to be aware of the care of the participants.

- Starting the session **by remembering how the interventions are going to take place** can help make everyone aware of how this is developing. This is relevant for different aspects, from requesting the floor to more basic aspects such as controlling the exposure time or managing the information for those who arrive late.

- One of the best ways to involve people at the beginning of a project is to ask them about their expectations. Knowing what participants want to achieve will help you plan future interactions and manage expectations.

- **Use the comments to decide how to act.** Although planning is important, sometimes knowing when to improvise is even more important. By collecting feedback from participants and considering their feedback, you can adjust at their pace and find better ways to facilitate the process.

- Using **different ways of participating** can accommodate diversity of personalities. You can ask them to use the chat to answer some questions, for example: "if you have understood, put a smiley face in the chat". You can also request that they use the "hand" tool to ask to speak.

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- Planning activities in **small groups** can help shy people talk more comfortably. In this case, make sure that the time you allocate to small group work is enough for everyone to speak and invite the groups to choose their spokesperson fairly
- In the groups you can often meet **different personalities and life experiences**. People with an outgoing personality, who control the language or the subject being discussed, can speak more than other people without these characteristics. Try to take this into account when giving the floor.

3.3.3 Times, rhythms and attention

One of the beliefs about online sessions is that they are boring or slow. This does not have to be true. You can build the workshop agenda in a way that is interactive and takes into account the needs of the participants.

- **All online facilitations and trainings cannot have modules longer than 45 minutes.** This means that after 45 minutes you will have to change activity (eg: change dynamics, pause, change type of interaction from verbal to written or vice versa, leave individual moments ... etc.) With enough pauses and changes, you can achieve a successful workshop of up to 6 hours. To have a sufficiently active rhythm throughout the workshop, it is useful to anticipate some collective moments, some individual moments and some moments in small groups.
- Do you know what "**Zoom fatigue**" is? After too many hours in front of the screen, it is very likely that people are very tired: switching between screen and non-screen is important and must be taken into account when planning training.
- Another thought that may be interesting is that people's **attention span** is lower online than offline: it is only 3 to 5 minutes during digital sessions. After 3 or 5 minutes something has to happen, even if it is something small: for example a change of slide, an interaction in the chat, a question to the participants. From time to time during the workshop try to remind yourself of this suggestion.
- Another reflection to create rhythm and not put the participants in a passive position is to "teach" in an **experiential way**: let the participants generate content by answering questions and that your role as a trainer is to add what is missing and put it in a framework common: this is **Experiential Learning.**
- Another reflection is to **hold the participants responsible for the times**. Always have visible on the screen that you share the countdown of when you return from the break or how much time you have available for an activity. This can help you and prevent the facilitators from being solely responsible for logging out on time. Tools like Timer Tab can be helpful https://www.timer-tab.com/.
- If you are giving training (which has some characteristics different from facilitations) it may be useful to take into account that adults only learn what they are interested in learning. To give them enough context (and for them to make the conscious effort to learn) you can make it clear and sufficiently frame what the **goal of what they are learning is** and place the participants in an active position where they can decide.

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- To maintain a high level of interest, you can use visual elements that capture the attention: a PPT presentation that is not boring or without too much text is a good way to provide a pleasant experience. Here you can find templates for your PPTs: https://slidesgo.com/.

Methods to be used in Education 4.0

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4 Methods to be used in Education 4.0

In most educational institutions, including universities, there is a dominant teacher-driven model (Lecture-Based Learning). In this traditional education, the teacher plays the main role – active – while the role of the students is passive. In a teacher-oriented classroom, the teachers themselves choose what students will learn and then assess students while they are learning. In this model, the teacher implements the course material by lecturing it to the whole audience. On the other hand, the student, on the passive side, only gets the knowledge from the lecture, and usually has a limited influence on the general subject of the lecture.

4.1 Student-Centered Learning

Description: Student-Centered Learning focuses on interests by recognizing students' needs as the main element of a learning experience. The learning process is focused on the students and they choose what they will learn, how they will learn, and how they will evaluate their own learning. This means that students participate in deciding how to learn, which is crucial to the success of the student-oriented approach. The students have an entire arsenal of help (books, photos, audio/video material, search engines, websites, e-mails, discussions). In this learning process, the teacher participates in "the back seat", which directs the learning process in such a way that the students gain the appropriate knowledge. The essence of this method of education is that students feel responsible for their own progress in learning.

Example: The Creative Semester Project (CSP), an elective interdisciplinary course for students at Warsaw University of Technology (WUT). In this case, although students are stimulated to act through methods such as problem-based learning & design thinking, is also an example of student – centered learning. The pilot module was launched in March 2014 by the WUT team for the implementation of innovative teaching methods. Students felt a great need to practice teamwork and interdisciplinary education. Interdisciplinary projects change the mindset of students and develop communication skills. The need that students feel is proof that they are ready and interested to be more involved in working on real problems, not theoretical ones. To succeed, the challenges should be carefully selected. They have to be something that can be solved in quite a short time range. The key factor is the engagement of teachers, students and players in the socio-economic environment (Benchmarking report, 2018).

Link: https://wdf.pw.edu.pl/wdf_en/For-Students/Courses (on-lined accessed: July 28th, 2019)

4.2 Problem-based Learning

Description: The PBL (problem-based learning) teaching method is an educational strategy in which students learn by solving problems and seeking solutions to these problems. The idea is to teach creative, independent work and allow to broaden the knowledge of the specific area.

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Example: The PdP (Product Development Project) is a course started over twenty years ago at Aalto University in Helsinki (Finland). Currently, it is coordinated by Aalto Design Factory (http://pdp.fi) along with partners from around the world. The PdP is mainly for students of engineering, industrial design, and business, but otherscan join as well. The course is based on innovative learning methodologies such as problem-based learning and design thinking. Design challenges are outsourced from business partners. The project usually includes the following stages: planning, research, concept creation, decision making, computer-aided design and development, prototyping, and assembly and testing. The result of the project is a fully functional product prototype. The phases of prototyping, assembling, and testing the project are strongly associated with practical experience in learning. An important assumption of the PdP program is that project teams are international, created in cooperation between Aalto University and a remote university. Thanks to this combination, the members of the team represent at least 2 nationalities. In addition, it is assumed that selected graduates of the course take care of and share their experience with the participants of the subsequent editions of the course. Activities are carried out in cooperation with the socio-economic environment, thereby entering the so-called third mission of the university and are elements of the long-term strategy of the university supporting students in acquiring relevant competences.

4.3 Co-creation

Description: Co-creation connects all stakeholders involved in a process to mutually elaborate a valuable result. Co-creation brings a valuable idea, which is the mixture and combination of ideas jointly developed by all stakeholders.

Example: An example of co-creation is Rat Relay. It is a unique three-day global product design hackathon organized in the Design Factory Global Network. Rat Relay simulates a real-world situation in industrial product development where very often one individual person or team is only working on a project for a limited time and not from beginning to the end. In Rat Relay projects are rotated around the world in slots and the projects are provided by sponsoring companies, startups, or NGOs.

Each institution starts with the project provided by their sponsor for the first slot and then hands over the project to the next institution in sequence. All the other slots before the last slot are done in different institutions. The last slot is for completing the project and finishing it to be ready to be delivered to the sponsor after the Relay. The last slot is done by the original Institution that launched the project in the first slot.

Each slot creates a hand-over material to sum up all the work they have been doing, the choices they made, ideas they created, etc., during their slot. As a process Rat Relay offers a unique experience of project planning, project management of remote partners working as "suppliers", product development and project documentation and working under expectations and deadlines from the customer or sponsoring company.

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4.4 Blended learning

Description: Blended learning is a method of education that combines traditional forms of education (classroom learning) with remote learning (distance learning, e-learning, m-learning). To better understand what blended learning is, let us refer to Graham et al. (2013), who distinguishes **technology-enhanced learning**, where there is no reduction in face-to-face contacts; and **mostly online learning** where the face-to-face contact is optional or missing. **Blended learning** is a method where the reduction in face-to-face contact is complemented by distance, mobile or online learning.

Currently, this concept is often redefined, where blended also means mixing contexts, changing media and approaches to education, where the ultimate goal is to increase the efficiency of learning. In particular, there is a distinction between the independent work that occurs on demand and is managed and controlled by the student, and learning in a group during which communication and sharing of knowledge or discussion take place (it can be face-to-face or on-line). Sing (2003) is also considering splitting b-learning formats into:

- synchronous physical, i.e.: classes taught by the teacher, lectures, laboratories, workshops, and field activities,
- synchronous online, i.e.: online meetings, virtual classes, online seminars, broadcasts, news, and online conferences,
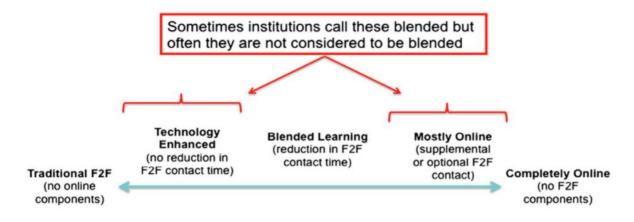- asynchronous independent, i.e.: work on documents, tests, and own work.

Figure 1 spectrum of course-delivery modalities in higher education. Source: Graham et al. (2013)

In general, b-learning is a tool that can support various elements of education, including international projects (e.g. the PdP, the SQUAD), or courses and classes conducted locally.

Example: Classes in accordance with the blended-learning method are conducted at SGH (Warsaw School of Economics). They are mixed classes, combining traditional activities (in the auditorium) and online classes on the e-sgh platform.

Link: https://www.e-sgh.pl/?page=wyklady-blended-learning&change_lang=en (on-line accessed: June 28th, 2019)

Tools for supporting Education 4.0

5 Tools for supporting Education 4.0

In this section, step-by-step approaches to pedagogical actions are presented. The tools described herein might contribute to increased knowledge and experience regarding Industry 4.0 of teachers and students. The presented tools can be freely used by teachers and trainers when planning the delivery of education. The aim of this guiding toolkit is to equip teachers and trainers with methodologies and tools for their pedagogical approaches to explore T-shaped skills in their classes and projects.

The document is based on a set of views and inputs of higher education institutions, companies, and public bodies that contributed to small-scale events and trainers' courses within the Universities of the Future project. The presented toolkits for teachers/trainers is focused on the use of innovative learning methods to explore T-shaped skills (and another one is focused on the use of technologies enriching the innovative learning methods).

The tools and methodologies described in this document are described according to the following scheme:

- name of a tool,
- category (canvas, workshop, game, lecture, tutorial, etc.),
- application to the elementary part of the education process (e.g. empathy, ideation, strategy, prototyping, etc.),
- description of a tool,
- external links, materials and internal resources.

Tools presented and briefly described in this toolkit for teachers are combined into several categories to make it easier to find a given tool in terms of the needs of its use within the framework of a specific, defined stage of project work. The following categories are referred to in the tools described herein:
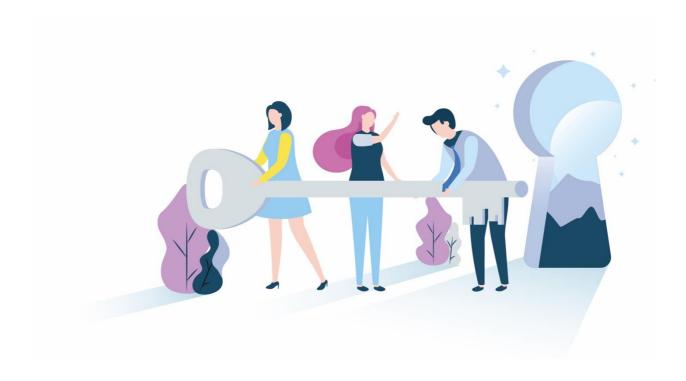
- **Identify needs** – a process of discovering a user's requirements, constraints, problematic features and events and motivations. This allows to get to know the needs of the user, himself/herself as such, to construct a character trait, or get to know how a product or a service would be of value to a user.
- **Research** – a systematic investigation and study of knowledge, materials, references and sources in order to establish facts and reach new conclusions.
- **Ideation** – an activity of ideas or concepts formulation based on assumptions and preceding studies.
- **Co-creation** – joint creation of value by an organization, users and other stakeholders, who work with an organization to co-construct a product or service experience to suit their preferences (Prahalad and Ramaswamy, 2004).
- **Collaborative making** – a working practice whereby individual users or other stakeholders work together to a common purpose in order to achieve organization or themselves benefit(s).

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- **Pilot test** – a small scale preliminary study conducted in order to evaluate feasibility, time consumption and deadlines' assumptions, cost, adverse events, and improve upon the study design prior to performance of a full-scale project of organization (Thabane et al. 2010). Basically, pilot testing means finding out if a survey, key informant interview guide or observation form would work in the "real world" by testing it first on a few people. The purpose of such an approach is to make sure that everyone belonging to a sample not only understands the questions but understands them in the same way. It also allows determining if any questions make respondents feel uncomfortable. It also allows to find out how long it takes to complete the survey in real-time.
- **Implementation** – a process of execution of a decision or plan into action.
- **Energizers** – a brief activity or action that is intended to increase energy in a group by engaging group members in physical cognitive activity into living atmosphere.
- **Team building** – a specific action connected to people gathered to work together as a team each with a particular aim and job description, job person specification, role, responsibilities and duties that provide a variety of forms of maintenance.
- **Process management** – actions aimed at defining a process, establishing responsibilities, evaluating process performance, and identifying opportunities for improvement.

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5.1 Design processes

5.1.1 Design Thinking

Description: The Design Thinking method consists of focusing on the users and gaining a deep understanding of their needs. The problem is solved by an interdisciplinary team, which favors a look at the problem from many perspectives. Subsequent activities are experimenting and testing hypotheses - building prototypes and modifying them based on feedback from users. The key statement is "It's ok to fail", which means that it is better to fail at the early stages of the project to succeed at the end. This methodology has a structure of actions to be taken to create a valid prototype that solves a defined problem.
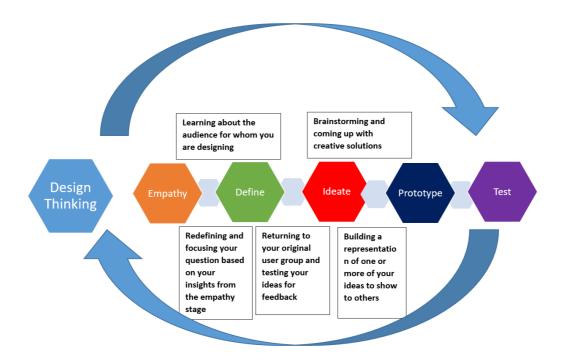

Figure 2 Design thinking requires the learner to work within a specific scaffold process to solve a design challenge, source: CC-SA 4.0, https://en.m.wikipedia.org/wiki/File:Design_thinking.png *(on-lined accessed: June 28th, 2019)*

Empathize consists of determining who the product is directed to, who will be the beneficiary. There is a deep understanding of the problems and needs of the product beneficiary, "entering the user's skin". One should recognize the hidden intentions, motivations, thoughts, and feelings associated with the designed product. The tools used in this phase include empathy maps, ethnographic interviews, user observations, and discreet observation, "user shadowing".

Define is the synthesizing of the information gained in the empathy phase. Identification of users' needs will be addressed. During this phase, one should avoid defining the solution and generalizing users' problems. The definition should be specific enough to allow for verification of subsequent

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solutions. Determining the correct point of view which will determine the further course of the project.

Ideate is to generate as many different solutions as possible. Generally, idea generation is carried out as part of brainstorming. Openness is required for various, even unconventional, crazy and unrealistic ideas. It is recommended to relax the participants before carrying out this phase. The group then generalizes the ideas and selects one that will be the basis for creating the prototype.

Prototype – know your failure earlier to succeed earlier. In this phase, a "physical" prototype should be created. Depending on the conditions, it can be built either from cheap materials – cardboard, cards, string, adhesive tape, etc., or from more professional materials. The type of prototype built depends on the budget, the duration of the project, etc. The purpose of prototyping is to verify and evaluate the idea.

Testing is the meeting of the prototype with the users. During this phase, a prototype should be presented to the user, then their remarks should be written down, and their reactions should be observed without commenting or entering into a discussion with him. The result is a refinement of the prototype.

Example: The Creative Semester Project (Polish: Kreatywny Semestr Projektowy, Kostrzewski 2018) is an interdisciplinary course with elements of problem-based learning & Design Thinking methodology. It is an elective subject for students at Warsaw University of Technology (WUT). The program is based on innovative learning methods and developing a student-centered learning concept. The pilot module was launched in March 2014 by the WUT team for implementation of innovative learning methods. The CSP includes elements of team building and introductory lectures on Design Thinking & problem-based learning, but the focus is on design and entrepreneurship elements. Effective cooperation between students from different faculties is a key factor for success in solving problems commissioned by academic tutors or non-academic partners. The CSP's mission is to encourage external stakeholders to get involved in the learning/teaching process. Non-academic partners provide real-life problems to be solved by student groups, and an employee to support and act as an adviser. If the problem is related to industry, students visit the company to see how they work and get more information on the topic. The CSP partners are mainly business partners, but Warsaw City Hall is also an active partner providing challenges in managing the city to make it friendlier to residents and guests. The grade students get is comprised of assessments done by students, team members, facilitators, and a reviewer. The students themselves, their teammates, and their facilitator assess the student's creativity, technical contribution, and ability to work in a team. The facilitator, the reviewer, and the other facilitators assess the final report and presentation of the project outcomes (Best practices report, 2018).

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5.1.2 Double Diamond

Description: The Double Diamond method is a variation of Design Thinking. It divides the process into two main stages: designing the right thing and designing the thing right. Between these two stages, the problem is defined. It is further divided into four distinct phases – Discover, Define, Develop and Deliver. The Double Diamond is a simple visual map of the design process. In the discovery phase, one gets insight into the problem, it is a divergent thinking phase. In the define phase, one defines the area to focus, and it is a convergent thinking phase. When the problem is defined, one develops the potential solutions created in the divergent thinking develop phase. The last phase, in which one delivers solutions that work, is the convergent thinking deliver phase.

Example: The SQUAD course is based on the Double Diamond process. It assumes: learning by doing – SQUAD requires a practical attitude; learning, not teaching – a teaching team runs teams all year round, helping to manage the project and organizing thinking; concentration on the team – collecting individual points of view and combining different disciplines and approaches creates better projects; finally, focus on the user, where real customers receive and evaluate the project.

The SQUAD project is attended by students from Universities belonging to the Design Factory Global Network. Triangles of such Universities are organized, where each of them provides students with a specific specialization: business students, designers, and IT specialists. Each team is created by six students, two from each university. The goal of the project is to solve the real problem of an existing company by a team of students.
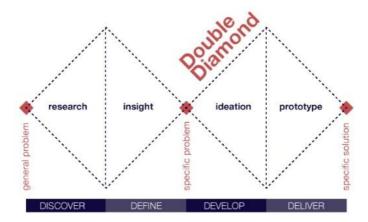

Figure 3 Double Diamond design process model. Design Council (UK), source: CC-BY 4.0, https://www.usableyaccesible.com/recurso_glosario.php#double_diamond_design_process_model (on-lined accessed: June 28th, 2019), https://commons.wikimedia.org/wiki/File:Double-diamond-process.jpg (on-lined accessed: June 28th, 2019)

The project lasts two semesters, assumes three meetings of students participating in the project. At the beginning of the project, the so-called kick-off meeting, during which students get to know, organize, integrate, get to know the work methodology and get to know the challenges they will face. In the middle of the project, the so-called midterm review meets, present what they have achieved so far in front of clients and plan further work. The project ends with the final gala, during which students present the results of their work in public.

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5.1.3 i-Teams

Description: i-Teams is a method of education that involves the participation of a multidisciplinary team of students. In addition, students are looked after by a mentor specialized in the industry. The goal is to assess the profitability of new technologies and the product being designed. Students participating in the i-Teams session gain practical experience in researching potential markets for innovation, while researchers (who are the creators of the product concept) receive feedback on their products from potential customers and business partners. Teams consist of up to 7 people, selected from different disciplines. They work with the support of a team mentor as well as other researchers. The course ends with a public presentation during which teams present their final conclusions to business and academic experts. Participants brainstorm the possible uses of their invention, explore ideas through contact with external industry experts. The course involves getting familiar with the processes required to transform laboratory technology, or a concept into a commercial product. Course participants gain practical experience and work on a real project using the "learning-by-doing" method in which your ideas and conclusions will influence future directions and results. The acquired skills and benefits of participation include: team-work and team management, brainstorming, determining the key benefits of commercial technologies or product innovation, identifying relevant competitors and potential associates, identifying and contacting relevant industry experts, developing your own network of contacts, applying the Human-Centered Design method, design and Lean Startup in technology commercialization projects, presentation skills.

Example: The University of Cambridge has several programs in accordance with the i-Teams method: Innovation i-Teams, Development i-Teams and Medical i-Teams. Each student of post-graduate studies or a PhD student from any faculty may participate in the courses. Students may also apply to participate in the Development i-Teams course. The duration of the course depends on the type – from 5 to 10 weeks. The program assumes weekly team meetings and at least 4 hours of individual work weekly. In addition, students are required to participate in telephone conversations/Skype.

Link: https://iteamsonline.org/ (on-lined accessed: June 28th, 2019)

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5.2 Team-building-

5.2.1 Marshmallow challenge

Skills to teach: teamwork, soft skills, communication

Category: energizer

Application: reveal hidden behavior and character traits, icebreaker

Description: The Marshmallow Challenge was introduced by Tom Wujec. It involves building the highest tower using spaghetti, string, adhesive tape and marshmallow. Participants divided into groups have 18 minutes to face the challenge. Due to the simple and freely available materials, the challenge can be performed in almost any conditions. In addition, due to their simplicity, they can be carried out with any group (from kindergarten to pensioner's club). In addition, participants tend to give in to high time pressure, which causes them to reveal some hidden behavior. Accurate observation can give the observer the opportunity to preliminarily refer to potential roles in group. After the challenge, you can conduct a reflection, which involves discourse with participants, showing them the need to create prototypes, show them what problems are present in teamwork, and why they failed or succeeded.

Instruction: https://docs.wixstatic.com/ugd/ca1bfa_a40d1ceb06444cfabeda5d9f0eab6ebf.pdf (on-line accessed: June 7th, 2019)

Equipment: 20 spaghetti sticks, masking tape, string, marshmallow, scissors (optional)

Link: https://www.tomwujec.com/marshmallowchallenge (on-line accessed: June 7th, 2019)

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5.2.2 Paper bridges

Skills to teach: communication, teamwork, soft skills

Category: energizer

Application: icebreaker, understanding of the importance of communication

Description: Paper bridges is a simple group exercise that helps participants to understand the communication problems that occur in typical group projects. The idea is that each group has to build a paper bridge that will hold a weight (e.g. telephone). The task is presented to groups (of at least 4 people), that are then divided into two equal parts. We establish a way of communication between group halves. This should be done depending on the type of communication in the project (meetings, skype, text communication, etc.) in such a way as to highlight problems that may arise. Half of the groups should work in separate rooms, building the halves of the bridge. You should give limited time to build. Subsequently, the halves of the groups meet and have a few minutes to connect the bridge halves. After testing, communication problems that affect the work process should be discussed.

Instruction:
http://www.4h.ab.ca/VentureOut/leaders/pdf/activities/how/Act19_Building_bridges.pdf   (on-line accessed: June 7th, 2019)

Equipment: Lots of newspapers, masking tape, string (optional)

Link: http://www.4h.ab.ca/VentureOut/leaders/pdf/activities/how/Act19_Building_bridges.pdf (on-line accessed: June 7th, 2019)

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5.2.3 Draw How to Make Toast

Skills to teach: system thinking, communication

Category: energizer, collaborative making

Application: icebreaker, system design exercise

Description: Draw How to Make Toast is an exercise that reveals how to create ideas, communicate and solve problems. It uses the concept of system thinking. It is an exercise preceding meeting on solving specific system problems and makes the most important elements of systemic thinking more engaging. It helps teams break down complex problems into smaller fragments together and more effectively. By visualizing ideas, it allows you to build and transform complex systems in a way that will make them better. Fosters transparency, involvement and adaptation. It consists of three parts: free drawing when we discover a system as a collection of links and nodes; drawing the nodes on sticky notes and iteratively reorganizing them; connecting the groups of nodes and synthesize the knowledge.

Instruction: http://www.drawtoast.com/ ,
https://docs.wixstatic.com/ugd/ca1bfa_2ec7fd42383449b3ad666d1bdb2754e3.pdf (on-line accessed: June 7th, 2019)

Equipment: thick paper stock, sticky notes, masking tape, clear wall

Link: http://www.drawtoast.com/ (on-line accessed: June 7th, 2019)

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5.3 Ideation

5.3.1 Brainstorming

Skills to teach: life-long learning, system thinking, T-shape, cross-cultural learning, soft skills, teamwork, communication

Category: identifying needs, collaborative making

Application: generating a lot of ideas, of different quality, in short period of time, a technique derived from social psychology, its aim is to improve group decisions

Description: There are two phases of brainstorming: silent one and discussion, in the case of which ideas are evaluated. The first phase consists of: writing down all the ideas that come to participant's mind, spontaneously. One idea per one post-it. The second phase consists of: reading aloud each of ideas and inventing new ones on the basis of already existing ones, disputing ideas and evaluating them. Some of the most specific techniques of brainstorming are: scamper, philips 6/6, coffee table, brainwriting, iceberg, mind mapping, etc.

Instruction: There is a vast spectrum of brainstorming methodologies, however we propose to utilize one of the processes described below. In the first phase, called "quiet brainstorming", participants are encouraged to freely report as many ideas as possible about the problem being discussed. It is important that at this stage people do not communicate so that they do not suggest ideas of others. All ideas are approved (e.g. post-it notes). The first stage of second phase assumes that the participants tell others about their ideas, explaining what they meant. This is the so-called "yes, and" phase, in which participants can build on the ideas of others, adding, detailing their ideas. In this phase, even the boldest idea reported by one person may become an inspiration for another, which will create a better, more real solution. The second stage of the second phase, called "clustering phase" involves grouping ideas that share elements, concerns a common idea, assumes a similar technical solution, or solves a common subproblem. This phase allows looking at ideas from above, to distance ourselves from ideas.

Equipment: large piece of paper or canvas, markers

Link: Rudy L.J. (2016), https://business.tutsplus.com/articles/top-brainstorming-techniques--cms-27181 (on-line accessed: May 29th, 2019)

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5.3.2 Mindmap

Skills to teach: lifelong learning, system thinking, T-shape, cross-cultural learning, soft skills, teamwork, communication

Category: identifying needs, research

Application: generating of derivative thoughts

Description: Mind map is one of the heuristic methods that allow illustrating the relationship between the basic issue and auxiliary issues. It is a versatile tool supporting the visual expression of thoughts. Mind Mapping was created in the sixties by Tony Buzan.

Instruction:

Participants should start by drawing in the middle of a blank sheet of a central image representing the target. Then it is time for shading or coloring the central image to specify it and drawing the first main branch (a thick line that radiates from the center of the map). After that, participants take part in creating second and third-level branches for side and related ideas; drawing up empty branches so that the brain can come up with their own ideas to add to them; writing down one keyword on each of the drawn branches related to the topic. Later on, participants may draw the next main branch of the next main topic and draw empty branches. They should be instructed to use images wherever possible, as images stimulate memory and to input the addition of links between branches in order to strengthen and highlight the strength of the links. Rules of using a mind map:

- o the use of accents:
    - a central image that will help you to focus on your goal,
    - images to coordinate the work of the brain hemispheres,
    - three or more colors to stimulate memory and creativity,
    - the effect of "three-dimensionality" both in pictures and around words,
    - reference to the senses - sight, hearing, touch, taste, smell, and sense of space,
    - differentiation in case of letters, drawings and lines to indicate the degree of materiality,
    - clearances;
- o use of associations:
    - arrows to direct the eyesight and indicate the connection,
    - colors to help you remember and make recalling easier,
    - codes (crosses, triangles, ticks) to mark associations that go through the map;
- o transparency:
    - one keyword on one line (the length of the line should correspond to the length of the word),
    - capitalized,
    - connection of main branches with the central image (main branches – thicker),

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- connecting successive lines with each other,
- vertical writing,
- arrangement of the card horizontally,
- clear drawings.

Equipment: a large sheet of paper, markers

Link: useful on-line software, which might be used in order to generate a mindmap:

MindManager (https://www.mindjet.com/mindmanager/, on-line accessed: November 26th, 2018)

MindGenius (https://www.mindgenius.com/home.aspx, on-line accessed: November 26th, 2018)

ConceptDraw MINDMAP (https://conceptdraw-mindmap.en.softonic.com/mac, on-line accessed: November 26th, 2018)

SmartDraw (https://www.smartdraw.com/?id=104640&gclid=Cj0KCQiArenfBRCoARIsAFc1Fqep4-A9r382I9UPxzmumOgBCvTl7fcNVR_nMbyEzNMwaoHaLnHbzhYaAmz0EALw_wcB, on-line accessed: November 26th, 2018)

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5.3.3 World café

Skills to teach: cross-cultural learning, soft skills, teamwork, communication

Category: ideation, co-creation, collaborative making

Application: a conversational tool to exchange information and ideas and to identify needs and expectations of all parties involved (but not to find concrete solutions), good for design phases related to warming up the atmosphere, ideas, thoughts, concepts

Description: The World Café method is known also as the coffee tables method. This method is based on seven principles for hosting conversations that matter: set the context, create hospitable space, explore questions that matter, encourage everyone's contribution, connect diverse perspectives, listen together for insights, and share collective discoveries. It is important to choose the right topics and questions for discussion when using this method - topics should not be too detailed and closed, as this can lead to the rapid exhaustion of creative ideas, but should concern participants, their knowledge and experience and boost generation of potentially new and diverse solutions. Participants are more likely to engage in discussions on topics that are important to them. If they refer to their own experiences and not to so-called well-known knowledge, there is a greater chance to get to know many points of view and to create a more complete picture of a given topic.

Instruction: At the beginning, the issues (topics) that the participants will work on are selected. For each issue, one table is assigned which is taken care off by a "host" (around one table one chair for „host" aka moderator and no more than four chairs for other participants should be included). Participants are divided between tables and start working in groups on tables' characteristic issues. A host begins with a warm welcome and an introduction to the process, sets the context, shares table's etiquette, and puts participants at ease. Working in one round takes 10-20 minutes, then everyone except a host change tables and thus an issue (sometimes a host may change a table for next round - then somebody other takes this role and welcomes the next group's participants and briefly fills them in on what happened in the previous round). Hosts remain at their tables and their role is to ensure that the rules are applied, and focus is on the issue that is intended for the table in question. After each round, a host summarizes what previous groups have said and encourages further discussion. After a few rounds (no more than tables), the hosts summarize and present the results. This is a kind of plenary session - summary of table discussions have times then. These results are reflected visually in a variety of ways, most often using graphics in the front of the room. You may find instruction on graphics as „The benefits of using graphic recording/ graphic facilitation" in links. The World Café should take place in a café or other place where a "café atmosphere" would be created (access to drinks, chairs around tables, loose discussion atmosphere). Properly arranged space allows discussion in an unofficial atmosphere - it is worth taking care of comfortable seating places, drinks and snacks, markers, pencils and pens, as well as paper tablecloths, after which you can write on any table, calm music in the background.

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Equipment: chairs, tables, markers, pencils and pens, markers, flip-chart, paper tablecloths, drinks and snacks

Links: http://www.theworldcafe.com/key-concepts-resources/world-cafe-method/   (on-line accessed: November 21st, 2018)

http://www.theworldcafe.com/wp-content/uploads/2015/07/graphicBenefits.pdf   (on-line accessed: November 21st, 2018)

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5.3.4 Cover story

Skills to teach: system thinking, T-shape, soft skills, teamwork, communication

Category: ideation

Application: visualizing ideas and concepts through the use of storytelling and word use formulas

Description: Participants imagine the future of the organization or any researched topic. This tool encourages people to "think big" but also it actually plants the seeds for an unpredicted future. This tool helps participants to imagine what it would be like if their wildest dreams had already happened. So, the moderator should encourage them to use the past tense in their brainstorming and story creation. The moderator should not let a group go into analysis mode but stick to plain fantasy. This tool is an open-ended, creative-thinking exercise.

Instruction: Participants should work in small groups that consist of 4-6 people. There should be following categories on the template:

- "Cover" tells the BIG story of their success.
- "Headlines" convey the substance of a cover story.
- "Sidebars" reveal interesting facets of a cover story.
- "Quotes" can be from anyone as long as they're related to the story.
- "Brainstorm" is for documenting initial ideas for a cover story.
- "Images" are for supporting content with illustrations.

The moderator should ask participants to imagine the best-case scenario for their researched topic and to take that scenario one step further. It is requested that they spend five quiet minutes imagining their own stories before they work together to agree on one. After group work, every story should be presented.

Equipment: markers, pens, pencils, a large piece of paper - moderator can draw similar canvas to the one given in link area (a template does not need to look exactly like the presented; the moderator can be creative with the central image and the layout, etc.)

Link: https://gamestorming.com/cover-story/ (on-line accessed: November 26th, 2018)

https://gamestorming.com/wp-content/uploads/2010/10/Playbook_620.png (on-line accessed: November 26th, 2018)

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5.3.5 Storyboard

Skills to teach: soft skills, teamwork, communication

Category: co-creation, pilot test

Application: this tool helps to describe a story or service prototype etc.; it shows a concept, action

Description: A storyboard describes a product in the form of a story and demonstrates a typical order in which information needs to be presented. It helps in determining useable sequences for presenting the information. A storyboard is a tool generally used in the film or advertising industry. The form of a storyboard known today was developed at the Walt Disney Studio at the beginning of 1930. It had also found its place in business. The first time, it was reached by Howard Hughes in Hughes Aircraft. Nowadays, they are used by the industry to plan advertising campaigns or other projects to convince or force action. There are plenty of different types of storyboard tools, e.g. Quality storyboard, which is a tool to facilitate the introduction of a quality improvement process in the organization.

Instruction: There is no such instruction, participants can think of their realization as short film and can design all sets and scenes as storyboard in a template with additional dialogs included nearby drawings. The storyboard can become a prototype of service or anything else which can be supported by that kind of idea tool. And they will reveal something amazing while putting pen to paper.

Equipment: templates, markers, pens

Link: http://www.bbc.co.uk/northernireland/myplacemyspace/downloads/promote-your-day-out/storyboard-template.pdf (on-line accessed: November 26th, 2018)

https://filmstoryboards.medium.com/japanese-anime-storyboard-templates-e8e314585a4a (on-line accessed: November 26th, 2018)

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5.3.6 Superhero

Tool: Superhero, a brainstorming tool

Skills to teach: life-long learning, system thinking, T-shape, cross-cultural learning, soft skills, teamwork, communication

Category: ideation

Application: A good method when team members/participant of a project should put themselves in somebody other's shoes in order to imagine and find out how that person (e.g. superhero) could solve a considered problem.

Description: The method is about the creation of a kind of superhero persona which potentially might have a problem to solve. This tool is similar to persona, however, it doesn't serve for a summary of users' opinions.

Instruction: Every participant draws a character card, e.g. with the use of canvas given as website link. The moderator should ask participants to imagine how this character walks, talks, feels and thinks. Participants can even take some time to write down the characteristics. That way they really get a feel for what a superhero is like.

And then participants are asked how their superheroes (or super-villains) would solve our problem.

Equipment: superhero canvas, pen, pencils, markers, flip-chart

Link: https://i0.wp.com/www.brainfueltool.com/wp-content/uploads/2018/01/werkblad-superhero.png?fit=3508%2C2480&ssl=1 (on-line accessed: November 21st, 2018)

https://brainfuel.nl/en/methods/superhero/ (on-line accessed: November 22nd, 2018)

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5.3.7 Lego serious play

Skills to teach: life-long learning, system thinking, T-shape, soft skills, teamwork, communication

Category: identifying needs, ideation

Application: building what-if scenarios, business processes and performance, service design etc.

Description: The LEGO® SERIOUS PLAY® methodology is an innovative process designed to enhance innovation and business performance.

Instruction: There are plenty of instruction. It is just for using bricks and imagination.

Equipment: Lego bricks, Lego Serious Play Starter Kit 2000414

Link: https://www.lego.com/pl-pl/seriousplay (on-line accessed: November 28th, 2018)

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5.3.8 TRIZ

Description: TRIZ (Russian: Теория решения изобретательских задач), a theory of the resolution of invention-related tasks. The creator of the method – Genrich Altshuller – based it on the assumption that the evolution of systems and technical solutions is guided by objective laws and proposed using these laws to closely guide the development process of the chosen system.

Today, TRIZ is a method, a toolkit, a knowledge base and a basic technological model for creating new innovative ideas and solving problems. TRIZ provides tools and methods to correctly formulate problems, system analysis, error analysis and possible directions of system evolution (the "is" and "can be" approach). TRIZ, in contrast to techniques such as "brainstorming" (which are based on random generation of ideas), approaches algorithmically to solve technical problems. It strives to create an optimal solution to the problem by improving existing solutions.

Example: The TRIZ method is used, among others, at the University of Oxford in the TRIZ Innovation Center. The Center runs a series of courses on TRIZ (both about this method and its use). These courses may be attended by people from outside Oxford.

Link: https://www.triz.co.uk/ (on-line accessed: June 28th, 2019)

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5.4 Understanding users

5.4.1 1-on-1 interview

Skills to teach: cross-cultural learning, soft skills, communication

Category: identifying needs

Application: understanding of users, their behavior and context

Description: A one-on-one interview is a conversation between an interviewer and an interviewee during direct contact.

Instruction: A one-on-one interview is a conversation between a researcher and a participant in a face-to-face situation.

Every time, the interviewer should specify a goal of the interview and select questions and subjects carefully around the topic. The interviewee should be informed about a goal and a topic of the interview. Interviews can be more or less structured (formal/less formal). A structured interview should have a clear guide to be followed by interviewer. A semi-structured (less formal) interview allows for flexibility during conversation. During an interview following acts should be performed: talking, watching, listening and observing of the interviewee. The conversation should be documented according to the proposed structure by taking short notes or by recording audio/video (if possible). After interview the gathered information should be analyzed and compared.

Equipment: notebook, voice recorder

Link: https://toolkits.dss.cloud/design/method-card/1-on-1-interview/ (on-line accessed: November 26th, 2018)

https://www.interviewcanvas.com/ (on-line accessed: November 26th, 2018)

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5.4.2 Behavioral lenses

Skills to teach: life-long learning, system thinking, T-shape, cross-cultural learning, soft skills, teamwork, communication

Category: identifying needs

Application: understanding of users, their behavior and context, how to change behavior

Description: This tool focuses on understanding user groups' behaviors and how to change those behaviors.

Instructions: Participants decide what is the targeted user behavior they want to accomplish and make a proper description of it. They also decide which lenses are related to the targeted behavior to be researched: habits and impulses, knowing and finding, seeing and realizing, to want and to be able, and to do and to keep doing. Participants define the influence of time, context, and impact of the described behavioral aspects on their users, and later draw conclusions. For chosen lenses, list the elements is read that influence the current behavior and how it relates to the one described in the lenses. Participants should take into consideration triggers and effects of the behavior. Participants use the intervention strategies on the lenses to ideate on ways that they can change the current behavior into the targeted behavior they want to obtain.

Equipment: pieces of paper, markers

Link: https://toolkits.dss.cloud/design/method-card/behavioral-lenses/ (on-line accessed: November 24th, 2018)

The design method 'The Behavioral Lenses' is the intellectual property of Hogeschool Utrecht (PubLab) and U CREATE (Center of Expertise Future Health Design).

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5.4.3 Persona

Skills to teach: system thinking, cross-cultural learning, soft skills, teamwork, communication

Category: identify needs, co-creation, collaborative making

Application: A Persona is a fictitious representation of a user or group of users for whom a product or service is developed (e.g. educational services, courses might be treated as such). Although it is a fictional character, it should have features similar to thr user. It is created based on the synthesis of information that has been obtained during quantitative and qualitative interviews, questionnaires, analyzes and observations (users shadowing) of real-life users. The purpose of building a persona is to better understand the needs, behaviors, experiences, goals, desires, and problems users have.

A persona is understood as a pattern of the users of a given product or service, with specific characteristics, predispositions, needs and objectives. It serves to ensure that the entire team has a realistic and consistent idea of the target user of a product or service. A persona is best for developing based on the results of research and analysis.

Description: A persona is a fictitious representation of a user type, made in order to better understand the user type.

Instruction: The first step in order to create a persona is research. The idea is to study users and learn as much as possible about them, their habits, expectations, and needs. Then, 1-2 pages of description are created (graphical design is preferred), containing details about her education, interests, values, needs, attitudes, and activities a persona carries out. It is worth giving the person a full name, age or age range, gender, appearance in order to make a fictional figure real, make it more human, and make users identify with it. In addition, it is worth characterizing a persona with sentences that are characteristic of itself.

Equipment: large piece of paper, markers

Link: https://www.designabetterbusiness.tools/tools/persona-canvas (on-line accessed: May 27th, 2019)

https://www.businessdesigntools.com/portfolio-items/persona-canvas/ (on-line accessed: May 27th, 2019)

https://www.innovationtraining.org/create-personas-design-thinking/ (on-line accessed: May 27th, 2019)

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5.4.4 Speedboat

Skills to teach: life-long learning, system thinking, T-shape, soft skills, teamwork, communication

Category: co-creation, pilot test

Application: identify what customers don't like about a product or service

Description: This is a tool for asking customers about their complaints, what's bothering them, in control of how complaints are stated and discussed. In the process, it is possible to find fresh new ideas for the changes that can be made to address customers' most important concerns.

Instructions: (Gray et al., 2010): First, draw a boat, visible to all players, with anchors attached, and name the boat after a product/service or goal under discussion. A boat figure is a metaphor for an activity – anchors represent obstacles slowing the movement toward the desired state. Then, write a question under discussion next to a boat, e.g. "What are the features you don't like about our product?" or "What's standing in the way of progress toward this goal?". Describe the Speedboat as a game designed to show what might be holding a product/service or goal back. Ask the players to review a question and then take a few minutes to think about the current features of a product/service or the current environment surrounding a goal. After that, ask them to take 5-10 minutes and write on sticky notes the features of the product/service they don't like or any variables that are in the way. If you'd like, you can also ask players to estimate how much faster a boat would go (in miles or kilometers per hour) without those "anchors", and add that to their sticky notes. Once players are finished, ask them to post sticky notes on and around anchors in a figure of a boat. Discuss the content on each sticky note and look for observations, insights.

Equipment: a large piece of paper or canvas, markers

Link: https://www.innovationgames.com/speed-boat/ (on-line accessed: May 28th, 2019)

Gray D., Brown S., Macanufo J., 2010, Gamestorming: A Playbook for Innovators, Rulebreakers, and Changemakers, O'Reilly Media, Sebastopol, CA, USA

5.4.5 Empathy map

Skills to teach: lifelong learning, system thinking, T-shape, cross-cultural learning, soft skills, teamwork, communication

Category: identify needs, co-creation, collaborative making

Application: It may be used in order to summary information about similar groups of users, as in the case of persona.

Description: An empathy map is a simple tool that allows profiling a group of users. It helps to better understand what people think and feel, focus on their experiences and needs. It allows going beyond the typical, demographic characteristics of customers. It was created by consultants from XPlane, and strongly promoted by Osterwalder and Pigneur (2010). A map of empathy is a simple canvas, divided into six areas with a set of questions. Areas relate to the user's interaction with the world and his or her internal feelings. One canvas is one target group or the corresponding persona. The areas on the empathy map are as follows: 1. what does user think and feel? 2. what and who does user listen to? 3. what does user see? 4. what does user think and do? 5. what are worries of a user? 6. what are user's aims?

Instruction: Prepare a whiteboard or large piece of paper. Define scope and goals – for who empathy map would be realized and what would be the primary purpose for empathy mapping. Collect research that you will be using to fulfill empathy map. Empathy mapping is a qualitative method, so you will need qualitative inputs: user interviews, field studies, diary studies, listening sessions, or qualitative surveys. After acquaintance with the contents of the tests carried out, each participant of this process individually generate sticky notes for each area of the empathy map.

Equipment: large piece of paper or canvas, markers, post-its

Link: https://gamestorming.com/wp-content/uploads/2017/07/Empathy-Map-006-PNG.png (on-line accessed: May 27th, 2019)

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5.5 Understanding current situation

5.5.1 5-why

Skills to teach: system thinking, T-shape, soft skills, teamwork, communication

Category: research, ideation

Application: understanding of a problem and its context

Description: The creator of the 5-why method is Sakichi Toyoda. During the development of industrial methodology, the 5-why method was quickly refined and implemented within the Toyota automotive corporation. The 5-why method allows reaching deep, often hidden or unconscious causes of particular problems. This method is used to determine the root cause of a problem. Asking "Why?" allows to interpret root of problems by thoroughly investigating their causes. By asking "Why?", the problem becomes more understandable, making the underlying cause of it easier to identify and eliminate. 5-why analysis allows to answer the questions: "why did the problem arise?", "why did not we notice him?", "how to solve it?".

Instruction: At first as much information about a problem as possible should be gathered. The more information is collected, the better is a chance for finding the true cause of a problem. Following aspects should be investigated:

1) what actually happened?
2) when it happened? in what circumstances?
3) what is the scale of the problem, how many problems/defects were identified, etc.?
4) what is the risk of a particular problem for a user/customer/ company?

The next step is to aggregate a working group (it is recommended that working group would consist of people who know the most about a place in a process/product/service where a problem has arisen – e.g. the production workers. Once a working group has been set up, you should describe the problem precisely and precisely. The 5-why method is to ask a question: "Why...<put a problem here>" and after getting an answer, another question is asked: "Why...<insert an answer to previously asked question>". This type of queries is repeated up to 5 times, on average. Statistically, the fifth question determines the cause of the problem.

Equipment: large piece of paper, markers

Link: https://www.tuzzit.com/en/canvas/5_whys_canvas (on-line accessed: May 27th, 2019)

Huber Z., 2006, http://www.huber.pl/articles/art-3.pdf (on-line accessed: May 27th, 2019)

Rules and tips helpful for proper analysis Brożyńska M, Lis A., Szymczak M., Kowal K., 2014, 5xdlaczego, 2K Consulting, Łódź.

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Other tools used to identify the cause of the problem:

- cause and effect diagram of Ishikawa (fish bone),
- Design of Experiments,
- Analysis of the change history (what was changed and when and when the problem occurred),
- FMEA method,
- statistical analysis (process capability index, Pareto, Anova, etc.),
- brainstorm.

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5.5.2 SWOT analysis

Skills to teach: system thinking, communication

Category: research, co-creation

Application: analysis and assessment of the potential of a given initiative

Description: The SWOT analysis is one of the basic tools of strategic analysis of a company. The name of this tool is the acronym for English words strengths, weaknesses, opportunities, and threats. It can be used for a whole company, or in particular spheres of its functioning, e.g. marketing, finance, production, etc. It can also be used in consulting as a technique of initial strategic analysis of a company (organization) which orders a consulting service. The categories used in the analysis are as follows:

- S (Strengths): everything that is an asset, an advantage,
- W (Weaknesses): everything that is a weakness, a barrier, a defect,
- O (Opportunities): everything that creates a chance for a favorable change, potential opportunities,
- T (Threats): everything that creates a danger of adverse change, probable or existing threats in surrounding environment.

Information that cannot be correctly classified into any of the above groups is, in further analysis, neglected as not strategically significant.

Instruction: The SWOT analysis consists of dividing the collected information into four groups (four categories of strategic factors), therefore at first a piece of paper should be divided into four parts. Then a problem under discussion should be presented to the working group and participants of such a group should write their ideas on sticky notes and attach them to a chosen category of strategic factors. One idea per one sticky note. The strategic information, sorted according to the described criteria into four groups, is then recorded in a four-tier strategic matrix, in which the left half contains two categories of positive factors and the right two categories of negative factors.

Equipment: large piece of paper or canvas, markers

Link:https://www.creatlr.com/media/workshops/canvas_img/9f01a40d28334c539cc18387abe5e1e6.png (on-line accessed: May 27th, 2019)

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5.5.3 Customer Journey Map

Skills to teach: life-long learning, system thinking, T-shape, cross-cultural learning, soft skills, teamwork, communication

Category: identify needs, o-creation, collaborative making

Application: tool for visualizing a customer's experience with a product/service

Description: The tool of Journey Map is a flow map that routes users' steps through an entire experience. This tool breaks down users' journey into component parts to gain insights into problems that may be present or opportunities for innovations.

Instruction: A Customer Journey Map is an illustration of a company's customer's experience in the entire process of using a service or product. When creating a journey map, a persona may be used. Then, the steps that this persona takes to use a given service or product should be specified. This approach helps to understand the whole spectrum of customer experience and to better understand its possible difficulties. After carefully determining the stages of customer's experience, it is necessary to indicate the so-called touchpoints, that is, the customer contact points with the service or product. In the next step, the activities and needs of a customer at individual stages are investigated. When a customer's expectations during an operation are considered, it allows companies to detect deficiencies and opportunities. This method allows companies to find out the moments that can be improved and make them more convenient, tailored to expectations, pleasant and encouraging to re-use.

Equipment: canvas (template), markers

Link: example and template: https://www.columbiaroad.com/download-your-own-customer-journey-map-template?hsCtaTracking=615c3cf0-1b36-4544-b9a3-28270214da4a%7C2b928844-a201-475c-b4b9-5b6cd238cfbc (on-line accessed: May 29th, 2019)

5.5.4 Carousel

Skills to teach: system thinking, T-shape, cross-cultural learning, soft skills, teamwork, communication

Category: process management

Application: pre-assessment or a review game of a broad, multifaceted topic; used for getting everyone involved, instead of hearing the same few students each time

Description: This game has been designed to gather facts and opinions from the participants on different aspects of the issue at stake. It helps to gain and share insights from all points of view since everyone will have had the chance to contribute. By limiting time, a group has to answer a question you will make them focus on the most important things. The idea is not to gather all information per participant but to gather meaningful information as a group. This gathered information will form the basis for prioritization and/or deeper research into some of the ideas and opinions.

Instructions: First, hand 4–5 large sheets of paper over around a room, with plenty of space between them. A different question or statement that can elicit a broad range of responses should be written on pieces of paper. Students should be divided into 4-5 teams – each team using a different colored marker. Each group begins at one of the posted questions. Each group has a couple of minutes to co-work. Instruction for students is as follows: "When I say go, you will have <…> minutes as a group to write as many intelligent points as you can on your board. When I call time, every group will take their marker and rotate to the left, just like a carousel." When groups rotate, students have to read through what the other group(s) wrote. If a student or group disagrees with something written previously, they are encouraged to draw a line through the statement and respond. After that, students begin to post their own additional thoughts. Continue rotating until all groups have responded to every question. Then facilitate a class discussion. All it takes to get great conversation going is a couple of lines drawn through comments of another color.

Equipment: a large piece of papers, markers

Link: https://www.acteonline.org/teaching-strategy-the-carousel/ (on-line accessed: May 27th, 2019)

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5.5.5 Stakeholders' map

Skills to teach: teamwork

Category: project management, research

Application: identify and map the stakeholders of the product

Description: A stakeholder is understood as "any group or individual who can affect or is affected by the achievement of the organization's objective" (Freeman, 1984). Mapping the stakeholders consists of four phases: defining the stakeholders, analyzing them by impact and influence, stakeholder planning and communication, and engaging with them. To define the stakeholders, we can use a variety of tools such as brainstorming, mind mapping, using generic stakeholder lists, identifying them using previous projects, and others. Analyzing them consist of completing an interest matrix, map the interests and power or influence on a quadrant developed by Bryant (1995). Next, we focus on the efforts on the highest priority groups while providing sufficient information to keep the less powerful groups happy.

Instruction: https://www.stakeholdermap.com/ (on-line accessed: June 7th, 2019)

Equipment: thick paper stock, sticky notes, masking tape, clear wall

Link: https://www.stakeholdermap.com/ (on-line accessed: June 7th, 2019)

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5.6 Forecasting the future

5.6.1 Trend hunting

Skills to teach: life-long learning, systems thinking, T-shape, cross-cultural learning, soft skills, teamwork, communication

Category: research

Application: useful for supporting discussion and debate around most relevant future trends

Description: This tool helps small and large groups to identify key transformative trends over the consecutive three years. Participants explore the consequences and business opportunities of trends.

Instruction: Participants collaboratively map the most relevant trends changing their industry over the next 3 years. Moderator explains to the participants what is understood by the term "trend" (driving forces in society that have strong and lasting consequences). Then participants work in four rounds, each of 5 minutes – rounds are connected to the following categories: *Business, User Behavior, Talent Demands,* and *Technology.* The participants' task is to brainstorm as many relevant trends in each category as possible. They are instructed by the moderator to write one trend per post-it, to speak trends aloud before sticking them on a wall in four clearly labeled category sections. After the four rounds, the moderator explains that the next step is prioritization of trends in terms of which will have the biggest impact (5 minutes). The moderator can use the Dotmocracy tool, which helps large groups to make rapid prioritizations. Using sticky dots or markers, each participant obtains 8 dots (votes) to distribute across the trends. They vote on trends that will have the biggest impact on the considered business over the next three years. Next, groups of 2-4 participants select the three most-voted trends to explore more.

Each group works with one trend, exploring its opportunities, consequences, potential risks, and imagining: *What does our organization look like in three years if we fully take advantage of the opportunities of this trend? What steps would we need to take today to begin moving that way?* The template may be used, and group work should take 15-20 minutes. At the end, the groups present their ideas in public and the moderator runs a short check-out to create a sense of closure.

Equipment: flipcharts, pens, markers, post-it notes, and tapes

Link: https://drive.google.com/file/d/0BzoYgdnM6xdBTElEUzB1cTZWRkk/view (on-line accessed: November 24th, 2018)

Trend template: https://drive.google.com/file/d/0BzoYgdnM6xdBN3E1eU9VR25rTmc/view (on-line accessed: November 24th, 2018)

5.6.2 Future mapping

Skills to teach: life-long learning, system thinking, T-shape, cross-cultural learning, soft skills, teamwork, communication

Category: ideation, co-creation, research

Application: useful for supporting discussion and debate around high-level themes: society, technology, politics, etc.

Description: This tool is used to create a shared view of industry trends in the recent past, present, and future. Participants define key trends from the past year, the current year, and three consecutive years in the future. They then review the map, identify patterns and discuss the relevance of different trends.

Instruction: First, the moderator divides a wall into five sections or sets up 5 flipcharts. At the top of each section or flipchart, the moderator writes the last year, current year, and next consecutive three years. Participants work individually with post-its and markers, where they write significant "forces" (trends, technologies, political movements, behavioral shifts, etc.) connected to the topic (focused on a specific theme or industry) and stick it to the wall/flipcharts. At the same time, they read their ideas aloud. This is a form of future vision co-creation through the lens of the past and the present. This should take c.a. 15 minutes. Then it is time to systematize all ideas. The moderator, starting with last year, gives participants 3 minutes to fill the space with post-its, then move to this year, and then each subsequent year. As the next step the moderator asks participants to view the post-its on the wall/flipcharts and look for patterns and common themes in each year. Next, the moderator stimulates a group reflection and discussion. Some useful questions for reflection and discussion stimulation might be: „what patterns do we see when looking at this timeline?", „which trends are most important for myself and for us to be aware of and learning more about?", „how do I feel about the past, present, and future?", „what does this mean for our team? our company? our industry? and what is my own role?". At the end, the moderator summarizes the discussion by sharing some of the key themes. The moderator asks the participants how they would like to capture their thoughts and actions to use in the future.

Equipment: a wall divided roughly into five equal sections with tape or five flip-charts, pens, markers, post-it notes, A4 paper

Link: https://toolbox.hyperisland.com/future-mapping (on-line accessed: November 23rd, 2018)

Phillips N. (1996), "Future-mapping: a practical way to map out the future and achieve what you want", Career Development International, Vol. 1, Is. 2, pp. 10 - 18, https://www.emerald.com/insight/content/doi/10.1108/13620439610114298/full/html

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5.7 Planning

5.7.1 Mock-up

Skills to teach: system thinking, T-shape, soft skills, teamwork, communication

Category: co-creation, collaborative making, pilot test

Description: Mock-ups support the presentation of physical/service/technology prototypes of a project in such a way as to bring its visualization as close to reality as possible, as well as to illustrate and emphasize its physicality and give the impression of realism in an appropriate scale. In manufacturing and design, a mock-up is a scale or full-size model of a design or device, used for teaching/learning, demonstration, design evaluation, promotion, and other purposes. A mockup is a prototype if it provides at least part of the functionality of a system and enables the testing of a design.

Instruction: It depends on the project – let participants feel free to choose, define, ideate, create.

Equipment: depends on a project, define them before any exercise

Link: https://www.interaction-design.org/literature/book/the-glossary-of-human-computer-interaction/mock-ups (on-line accessed: April 23rd, 2021)

https://99designs.com/blog/tips/creating-professional-mock-ups/ (on-line accessed: April 23rd, 2021)

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5.7.2 Business model canvas

Skills to teach: lifelong learning, system thinking, T-shape, cross-cultural learning, soft skills, teamwork, communication

Category: identify needs, co-creation, collaborative making, implementation

Application: positioning of a ready-to-use product or service in a business area

Description: The Business Model Canvas is a visual representation used in order to design new or to describe existing business model(s). The simplicity of these models allows preparing a basic analysis of a company. BMC is a visually presentable company, represented values, infrastructure, customers and financial flow. It allows the company to see new chances, opportunities. BMC was first proposed by Osterwalder and Pigneur (2010).

Instruction: The business model canvas (scheme) consists of nine blocks representing different aspects of the company's operations (Brante Partners, 2017, the following questions are quoted from Brante Partners, 2017). All of them should be completed as a result of working group discussion.

1. Value proposition: What problems are being solved for the company's customers? What is the value of the company's customers? What will customers pay for? What is crucial for customers? What products and services are targeted by a company?
2. Customer segments: Who is a company's customer? Who does a company build a product/service for? To whom does a company offer value? Who will pay?
3. Channels: Which channels will a company use to contact a customer? How will a customer find out about the company's products/services? How will a customer be able to purchase the company's product/service? What will the after-sales support for a customer look like?
4. Customer relationships: What kind of relationships do company's customers expect to have with the company? Do customers expect personal support or fast and automatic service? Is a way of customers relations arrangement integrated with other areas of a business model?
5. Revenue streams: What are customers willing to pay for? What will they pay for and how much they would like to pay? Which elements of a company's product/service will be free and which elements will be paid for?
6. Key activities: What actions do company need to take to deliver value to its customers? What actions do our customer-facing channels and relationships require?
7. Key resources: What key resources does company need for its proposed value to reach the recipient? What resources do company's customer-facing channels and relationships require?
8. Key partners: Who is our key partner? Which external companies or organizations are necessary for company to operate? What are key resources and activities of company's partners?
9. Cost structure: What are the costs of company's business model? What financial outlays are generated by company's key resources, activities and partners?

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Equipment: large piece of paper or canvas, markers

Link: https://canvanizer.com/downloads/business_model_canvas_poster.pdf (on-line accessed: May 28th, 2019)

https://www.strategyzer.com/canvas/business-model-canvas (on-line accessed: May 28th, 2019)

Osterwalder A., Pigneur Y., 2010, Business Model Generation, John Wiley & Sons, Inc., Hoboken, New Jersey.

Brante Partners, 2017, http://brante.pl/business-model-canvas-jak-wypelnic/ (on-line accessed: May 28th, 2019)

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5.8 Project management

5.8.1 Kanban

Skills to teach: teamwork, communication

Category: collaborative making, process management

Application: project, process, and workload management

Description: Kanban is a popular framework used to implement production, software, and project development. It requires real-time communication of capacity and full transparency of work. Work items are represented visually on a kanban board, allowing team members to see the state of every piece of work at any time.

Instruction: A Kanban board consists of several columns, e.g.: To do, In progress, Done. Participants define task to be realized during a project and put then on the first column in a Kanban board. Every participant can be characterized by different post-its colors. When a task is started, it should be moved to the proper column. The same after the completion of a task.

Equipment: Kanban board, post-its, markers, pens

Link: https://images-na.ssl-images-amazon.com/images/I/71PFUkkGfdL._SL1500_.jpg (on-line accessed: November 28th, 2018)

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5.8.2 Gantt Chart

Skills to teach: teamwork, communication

Category: project management

Application: graph used in project management

Description: It includes the division of the project into individual tasks and scheduling them over time. The first tool of this type was created by Karol Adamiecki in 1896, but he did not publish it until 1931. The name of these diagrams comes from the name of Henry Gantt, who developed them in 1910. With this technique, you can control the implementation of the planned project. The primary goal is to support the work of the project manager by highlighting the relationship between tasks and the impact of potential changes on the entire project. On a typical Gantt chart, rows contain work positions, while columns represent time units. The layout of events on the chart is most often presented in the planned version before the start of the operation and the actual one plotted on the graph over time. Using the Gantt chart, you can not only plan and control the implementation of the plan but also take into account the variability of the task execution by applying the appropriate system of markings.

Instruction: https://www.vertex42.com/ExcelTemplates/excel-gantt-chart.html (on-line accessed: May 30th, 2019)

Equipment: large piece of paper or canvas, markers

Link: https://www.vertex42.com/ExcelTemplates/excel-gantt-chart.html (on-line accessed: May 30th, 2019)

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