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The Role of Technology in
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INTRODUCTION:

The Role of Technology in Reforming Design Education: Pedagogy – Critique – Transformation

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#education models

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#softskills

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Design education has significantly changed since the 1950s. The era depended widely on normative models such as those proposed by Benjamin Bloom (Bloom et al. 1956) and his collaborators, which resulted in the formulation of Bloom's Taxonomy¹. Comprising six interchangeable layers (knowledge, comprehension, application, analysis, synthesis, and evaluation) of higher and lower thinking, Bloom's taxonomy sets in place an archetypal model for education that thrives on object-driven goals. Here, pedagogical interchange and the object-driven and organised structure of education can adapt to each layer within the taxonomic structure².

Nearly 50 years later, the second international Engineering and Product Design Education Conference (Lloyd, Roozenburg, McMahon, and Brodhurst 2004) chose the theme "The Changing Face of Design Education" to outline a radically different view of design education. The conference triangulates curriculum development using nine categories: philosophies of education, evolving design expertise, teaching tools, problem-based learning, studio-based design projects, design education and the internet, collaboration and the design education industry, collaboration with international connections, and specialisation. In the opening pages, Sietske Klooster, Richard Overbeeke and Kees Appleby (2004) define the intricacies of new curriculum development as specifically focused on a two-level system of core and meta-competencies. These core competencies include ideas and concepts, integrating technology, focus and perspective, social and cultural awareness, market orientation, and visual language. In comparison, meta-competencies include multidisciplinary teams, the design and research process, and self-directed and continuous learning.

A side-by-side comparison of Bloom's taxonomy with the newly proposed curriculum highlights that design education has transformed into a distinct domain and a discipline in its own right. It

also shows how external factors impact education in light of new dissemination practices. A wider scan of the research and formation of design education as a field reveals two interesting facts: first, the transformation of education into an enabling praxis shift education away from a craftsmanship emphasis with a 'look over the shoulder' approach, towards an online driven education model that emphasises cross-disciplinary ecosystem and networked collectives; and secondly, education practices are increasingly fusing research with education together with the acquisition of other new tools, such as gaming tools, modelling tools, fabrication tools and representational tools.

In studio-based learning, students undertake a long journey of idea generating, problem-solving, evaluating, and refining their designs throughout the learning process (Oh 2018). Therefore, active communication between faculty members and students is imperative in this specific learning environment to help students remain motivated during the design cycle. Studios are critical in design education as they provide a simulation of industry practice (Brusaco 2000). In this setting, teachers are the area experts who guide and mentor students with their projects. Thus, studio-based learning is an essential teaching approach and a unique pedagogic method (Broadfoot and Bennett 2003) within design education, where face-to-face tutorials and peer learning happen continuously. Interactivity in the studio fosters a proactive learning environment. Students feel more involved in the project and more comfortable approaching educators, who give prompt feedback to their students in a designated physical space (Ma 2016).

In this ever-evolving context, more questions arise. How can technological development today help studio-based learning take place in a virtual space? Can technologies transform and reform design education? Beyond the pandemic, can online learning replace face-to-face tutorials

across different disciplines within design education? And how should design educators adapt to the new direction this era is facing?

1. Setting New Targets Within Education

As designers, we observe users in the context of their lives in order to support critical problem-solving processes and propose new meaningful solutions. Design educators should apply the same approach to education systems to better understand their users, usually young people. This includes the changing nature of design education (DE), not as a mere knowledge transfer model but from a position that views DE as a peculiar kind of service. This highlights the need for educator responses to consider the younger generation's peculiarity with regard to how they build, create, and retain knowledge within the methods of DE and available mechanisms.

There have been two main approaches to the history of education. The first considers the student as an empty container, a head to be well filled. The second, put forth by the French Renaissance philosopher Michel de Montaigne (1533-1592), considers the student as a pupil whom the professor must teach methods in order to handle problems. In a figurative way, this causes a polarity between a well-filled head (full of notions and chunks of knowledge) versus a well-made head (structured to actively manage information and raw knowledge). However, both approaches focus on students as targets of education, occupying the centre of educational endeavour.

Traditionally, the term 'pedagogy' is derived from the classic Greek παιδαγωγία (paidagōgia), referring to the activity of leading a younger individual (Merriam-Webster 2020). Contemporary methodology retains this position as part of its credo. John Dewey (1991) emphasises that education is

not about telling or being told, but is an active and constructive process. Students construct their own experience and knowledge and learn by doing; the real process of education is the process of learning to think through the application of a real problem (Dewey 1997). To this effect, education is witnessing 'new generational' pupils as active participants, wherein co-creation, multitasking, non-linearity, working on-screen and sourcing rather than facts remains the premise.

As the millennial generation (Reinhardt et al. 2009) comprises digital natives, these students come to higher education with extensive knowledge of and experience with advanced technologies. Universities now employ various teaching technologies to improve student motivation, engagement, involvement, and learning experiences, while encouraging students to use these technologies in traditional classroom settings. As a result, students have undoubtedly become more inquisitive about new technology and possess high expectations for an effective learning experience. Despite this, while a number of studies recommend applying appropriate technologies to teaching and learning in the traditional classroom environment, little attention has been given to the use of technology in design education. We aim to find intriguing and challenging articles in order to uncover this research gap of technologies in design education.

Humans are formed and shaped by technologies and related devices. The advent of the web, ubiquitous digital networks, and the accessibility of a huge range of devices, such as smartphones, personal computers, and others, have changed human behaviour. These technologies have had different impacts on the various generations, with greater effects on the latest ones: the so-called digital natives.

Stewart Brand is an American writer, best known as editor of the *Whole Earth Catalogue* (1968-1971), and founder of a number of organizations,

including The WELL, the Global Business Network, and the Long Now Foundation. He writes: “Lots of people try to change human nature but it's a real waste of time. You can't change human nature, but you can change tools, you can change techniques. And that way you can change civilisation.”³ Tools and techniques can change mindsets and behaviours. This is especially true for digital natives: people who have learned from the cradle to interact with the digital world.

This way of accessing knowledge forms a different cognitive model, far from the traditional categories of thought referred to in the Enlightenment rationality (attributing labels, organising categories, and creating rational knowledge maps). Digital natives approaching vast arrays of data will abandon aseptic analysis, open to including greater fields or ranges of information to inform their thinking and conceptual development. Creativity, which focuses on connecting dots, becomes the key activity. For Michel Serres (2014) these young people express a “real intelligence”. They like to be active learners and want to engage with what they learn by using their learning environments, such as virtual classrooms or digital learning spaces (Massive Open Online Courses or MOOCs, YouTube, and other social media platforms).

Technology has always been part of their lives, and they don't feel awkward adopting and integrating it into their learning experience. For example, social media plays a critical role in their lives, both for socializing and learning skills (Oh 2018). Lee Andrew Dunn (2013) postulates that social media may offer an enhanced learning experience when given a constructive direction. Douglas Fusch (2011) argues that equipping students with digital life skills is equally important to the learning objectives. These new generations enjoy having class discussions and an interactive classroom environment to immerse themselves in the learning.

There are some consequences that educators must consider, however: the social-digital generation (Hietajärvi et al. 2015) access new information and process a vast number of images relatively fast. As illustrated from table 1, Hietajärvi outlines the differences between the conventional and socio-digital participatory models within education. In this scheme, reading papers and books seems peripheral to the flexibility digital mediums provide, where synthesis is the new keyword, even for educational purposes.

Socio-digital participation	School practices
Flexible use of digital media	Traditional media, e-mail
Multitasking	Linearity and sequence
Intellectual ICT tools	Pure mental performance
Internet searches	Limited textbook content
Socio-digital networking	Off line working, face to face
Working on screen	Paper and pencil
Making and sharing in groups	Individual performance
Extended networks	Closed classroom community
Knowledge creation	Knowledge acquisition

Table 1: Digital Generation's participatory models versus School pedagogies' approach (Hietajärvi et al. 2015)

2. Pedagogical Issues

The greatest concern we face in design education today is how to teach creativity using the ‘learning by doing’ method. To succeed in design-related subjects and projects, students need to master the theories and practical skill sets required to “make” things. For example, the Design Department of Politecnico di Milano uses a triangle to represent their method of teaching and learning design (Figure 1). Every angle represents the students' actions and relative teaching formulas, which include traditional lessons, workshops, and multi-disciplinary courses.

The premise of the 'learning by doing' approach is three-tier based. The first focuses on "being," or soft skills: learning how to interact with others and how to solve problems. The second addresses "making" as practical activities, such as sketching and prototyping. The third tier relates to "knowing," often seen as the conventional approach to absorbing knowledge by way of lessons or tutorials, supported by reading and studying. The properties of this triangle have in itself mutated, as demonstrated in Figure 1. From the left to the right of the image, the first pedagogical cluster differentiates between knowing, making, and being as three separate parts. Wherein the second version reduces the knowing component and moves it closer to the making and being components. The third and last version repositions knowing between and within both making and being.

Thanks to these cognitive transformations, "being" and "making" appear to become central activities for learning, even as they support the traditional activity of "knowing" that creates the real active learning process. Making as an expression of active learning thus fits the purposes of design education. When students enact "making" in class, they often carry this out under a project-based learning approach. Students work together, meaning they have to manage collaboration issues, leadership, and negotiation processes. Making together is the main route to absorbing knowledge (referred to as the traditional definition). Passion, an expression of soft skills within the groups, is a powerful amplifier of creativity and problem-solving orientation. Finally, making things together (and therefore being: humans exploring themselves in relationships) sets a new tone for the education mantra.

Learning by doing has been an essential teaching approach for design students. For instance, project-based learning focuses on constructivism by encouraging students to handle a project on their own with authentic problems provided. From there, students should focus on a "learning

by doing" approach, in which they engage with an autonomous learning mode with the aim of becoming more creative. Autonomy and collaborative problem-solving skills are expressions of the *smartness* approach, transforming soft skills into *smart skills*. Using authentic problems to challenge students can provoke creative thinking skills and increase motivation. Studying becomes more motivating, and students are most creative when they feel motivated primarily by a sense of interest, satisfaction, and challenge from the study itself, not by external pressures (Amabile 1998).

"No Maps for These Territories" (2000), a documentary film by Mark Neale, focuses on science fiction writer and father of cyberpunk, William Gibson. The film describes the inability to create complete maps in the age of complexity, especially within this tech-driven world. The ability of Generations X and Y to access vast repositories of data and information anytime and anywhere further exposes the difficulty of creating representative maps related to many kinds of knowledge. As educators, our responses should identify what possible contributions are viable within the student generations and what exact knowledge should be transferred with each generational shift. Educators should aim to provide a supporting compass as students make personal choices, connecting the dots of the immense repository available on the internet. Knowledge creation requires an understanding of what is "north" or "south" of such knowledge maps, similar to the use of a compass for directions when navigating through and across information online. Acquiring competencies in order to distinguish the value (and authenticity) of Internet resources is a key concern in both the active search for knowledge and the validation of its findings.

Essentially, the design education compass requires four key aspects. The first aspect supports an active process in making and being, and, consequently, knowing. Second, guidance enables

overtime (intrinsic) motivation, which makes students co-responsible for their learning process. The third aspect facilitates collaborative activities, taking the view that together is better than alone as a way to enhance soft skills. A fourth aspect prepares designers to face real-world complex problems to create novel artefacts.

‘Learning how to learn’ is therefore a key consequence of such educational compasses. For instance, it can induce more of a critical thinking process or independence and autonomy in learning. Independent and autonomous learning have been crucial points in evoking students’ intrinsic motivation. Through the right learning approach, students can stay motivated throughout their creative endeavours. When looking at a design setting from an educational perspective, students usually work on projects with authentic problems, build experience, and learn from those very experiences. As Phylis Blumenfeld et al. (1991) state, project-based learning (PBL) highlights knowledge acquisition, level of engagement, and motivation. This knowledge-building process includes experiential learning, which helps students generalize, internalize, and conceptualise their understanding.

The teaching of creativity brings forth new epistemes. In the past, studio-based learning has been the primary method for design education. However, project-based learning has been actively adopted by design educators. Therefore, in combination, project-based learning (PBL) is the epistemology that brings real-world problems to the classroom and lets students construct their own experience and knowledge through learning by doing. Students become more engaged, autonomous, and motivated through PBL, which provides opportunities for building and constructing experiences and abstracting concepts by observing and participating (Kolb 1984).

3. Digital Transformation and Impact in Design Education

Returning to the aforementioned context of the digital paradigm, new modes of education happen everywhere and anywhere thanks to new media and advanced digital devices. Higher education has increasingly employed virtual classrooms and distance learning models as core components of their learning practices. As the millennial generation (Reinhardt et al. 2009) largely comprises digital natives, learners come to higher education with extensive knowledge of and experience with advanced technologies. Philosopher Michel Serres (2014) observes the impact that digital technologies have on new generations: how they love, live, interact, and learn. He gives the image of a modern Thumbelina (1846), the female version of Tom Thumb (the novel of Charles Perrault, 1628-1703), who, upon opening her smartphone, acts and thinks through her fingertips, accessing the infinite amount of information on the web, accessible with a single touch. Serres’ choice to use the female version of Tom Thumb (Thumbelina) is related to a progressive feminisation of society, a phenomenon Serres connects to the millennial generation and its context of advanced technologies.

Traditionally, the studio-based learning environment has been the quintessential education model that fosters student-teaching interaction (Oh 2018). The studio, or face-to-face setting, provides immediate access to field experts and their professional conduct (Brocato 2009). One-on-one tutorials actively engage students with their learning process (Ma 2016; Oh 2018), and although labour intensive, remain the preferred setting to boost students’ understanding of their purpose and academic goals. Today, many higher education institutions have begun adopting online tutorial sessions for non-design faculties to boost students’ independent learning (Shaw 2012).

Furthermore, universities now employ various teaching technologies to improve student motivation, engagement, involvement, and learning experiences, while encouraging students to use these technologies alongside traditional classroom settings. As a result, students have undoubtedly become more inquisitive about new technology. On the flip side, technology-skilled learners raise the expectations of an effective learning experience. Despite this, however, while several studies recommend applying appropriate technologies to teaching and learning in the traditional classroom environment, little attention has been given to the use of technology in design education. This timely topic provides intriguing and challenging possibilities for exploring the area of technologies in design education.

With the global pandemic in full force, educational sectors have been forced to immediately convert full curricula into online teaching modes. New technologies have helped support the possibility of substituting traditional classrooms/tutorials in design education, co-evolving technological advancement, and transforming the technological relationships to studio settings. Even so, many design educators believe it would be too challenging to conduct studio-based learning using online tools and insist on a face-to-face format for their teaching and learning activities. The pandemic, the convergence of digital tools, and the growing ease of technology with every day mark an opportune moment to reconsider the potential opportunities that online learning can provide moving forward. Technologies such as mobile devices and laptops enable both teachers and students to explore online-driven pedagogical tools. These technologies can overcome barriers of difference and distance, thus facilitating discussion and exchange of ideas. Miro and Conceptboard, two online collaboration platforms, are examples that have shot to popularity during COVID-19, meant to facilitate active online communication as effectively as in the studio, even as dematerialization

occurs with the shift from the strictly physical studio to the virtual space.

Adding to this, new forms of teaching and learning can happen anywhere, extending the studio outward into a variety of personal settings. According to Joi Ito, a former director of MIT Media Lab, "Education is something that is done to you. Learning is something you do for yourself" (as cited in Evers 2017). Ito posits learning over education, emphasising how to learn and not simply acquiring a body of knowledge (Evers 2017). Learning solicits transformation of the teaching systems into one that is supportive and works well for the learners, rather than one that is simply informative. At one level, this requires technology support, dependent on high-speed internet connections and high-performance computing, both affordable and accessible without delay. On another, especially in this internet era, there is a dependency on third-party resources and self-directed opportunities for students to learn from the Internet. While it is certainly difficult to say whether all the programmes students can find on the internet are certified or guaranteed, there are many basic tools that students can pick up to start their first steps in design education. The practice of including social media and dedicated platforms, for example, YouTube and Archistar, is embraced by both educators and students equally. Students can explore free online tutorials that teach how to use software for drawing skills, digital painting, colour theory, and many other transferable skill sets. These online tutorials can be more effective in transferring knowledge than the traditional learning process, with educators teaching and guiding students step-by-step in online learning environment. In online learning, there are no project-related issues, as the focus is on mastering the software for students to apply the skills to refine their projects. YouTube can effectively perform the function of knowledge transfer, and it has become a popular learning arena for those who have a shared interest.

This trend advocates for transmedia learning, which adopts storytelling techniques to engage learners more efficiently; students can relate to the content first, then understand, and finally share with others (Franceschin 2016). These storytelling elements can greatly attract learners and engage them deeply. Students feel learning is more exciting and efficient when they do not just memorise content, but understand and share it within a community.

Tomás Franceschin writes that transmedia learning can transform the education of Latin American countries. His article for edu4me proposes solutions:

“This technique has actually been borrowed from entertainment, where producers usually combine different media to tell and promote a story. This can clearly be observed in Hollywood, where any given movie entails far more than the film projected on the movie theatre, as it is expanded into video games, mobile apps, social media pages which display original exclusive content in multiple form factors, soundtrack albums, and many other formats. In education, Transmedia involves the usage of one or more of these channels to develop a coherent story involving a specific content or topic, allowing students both to research and comprehend it and to conceptualise it in such a way that they can adapt it to the different formats. Additionally, this method allows students to get deeply involved in the process of creating content, teaching them how to write, film, edit video, animate, code, or whatever task is needed to complete each project.” (Franceschin 2016)

With digital transformation and the rise of sustainability concerns, designers are leaving the traditional idea of closely defined artefacts in favour of flexible solutions that are accessible to other stakeholders (mainly customers). A simple example could be a customisable pair of shoes. In this particular instance, digital platforms allow users to combine components and details, focussing more

on the values of the customers than mere durability. Platforms such as OpenIDEO⁴ are enablers to a global community that aims to provide solutions for social and environmental problems with a ‘design thinking’ approach. These cases show another rule that guides designers. The “enabling rule” triggers and encourages user participation in the production process. We have seen the importance of co-generating knowledge in the learning process, anytime, anywhere, and across different media platforms. In educational institutions, teachers set the goals and provide compasses wherein students learn to be creative within the parameters. From this point of view, professors become life coaches, enabling and helping students to find their way of learning and growing. When universities design curricula and programs, the “enabling rule” remains a key question. A platform must fit with the students’ lives, account for generational differences, and minimize the difference between online and offline life: for example, Generation Y versus the values of Generation Z, and their daily experiences (Floridi 2015).

4. About the Discipline

Today, design deals with aspects such as social innovation, social justice, social movements, politics, participatory action, educational processes, gender differences, and other aspects of individual and social life. It happens amidst a trigger that aims at combining different competencies; therefore, a trans-disciplinary approach is needed. An approach that transcends disciplinary approaches by adopting an inclusive framework, generating mutual learning, joint work, and integration of knowledge with the primary aim of problem solving. This approach remains a project-based learning process that aggregates different competencies and experiences.

Ezio Manzini (2015) claims that everyone is a designer: a person who can imagine their future

and find ways to improve the quality of life. For Manzini, there is a difference between a “design expert” and a person who is the subject of education. The design expert acts within the community to provide their expertise, presents visualisation capabilities, and is orientated toward the future. Expert soft skills, which consist of empathy, collaborative problem solving, negotiation and entrepreneurship, become a fundamental set of competences. For the discipline of design, criticism and meta-competence need to be emphasised.

Criticism is the way learners understand contexts and situations. Criticism is the ability to analyse the consequences of every projectable choice, the capability of engaging people, and the sense of value assessment for every executed action. For design education, constructive criticism is an essential component, feeding into the process of how students execute their projects, which in the long run aids in establishing an autonomous and professional mindset. The critique or ‘crit’ session is therefore mutual, relating to both teacher-student interactions and a peer-to-peer mechanism.

Meta-competence assumes a humble disposition towards understanding people, being aware of what we do and how educational practices fill the knowledge gap. This is a typical design approach, considering the initial set of information and lack of knowledge when commencing a new project. Professional design methods rely on the experiences that constitute knowledge, which in a student setting of project-based learning is part and parcel of an experiential learning cycle that generalises, internalises and conceptualises students’ understanding (Kolb 1984).

Number 4 of Cubic, Design Education - Technology’s Role in Reforming Design Education, Pedagogy, Critique, Transformation, contains eight contributions to reflect on the challenges of education in the design context. **Peter Vistisen, Bo Allesøe Christensen,** and **Thessa Jensen** explore

the theory of Ulrich Beck on risk-taking, combined with current design thinking ideas in their interdisciplinary workshop. For **Michael Louw**, the possibility of radically dislocating the design studio from its traditionally centralised space to the site of investigation takes precedent, as demonstrated in his photo essay. **Gladys Lam Wai Ling** examines the application of blended learning approaches in advertising design, discussing three blended learning strategies conducive to meaningful learning for students. **Iain Choi** and **Fann Zhi Jie** explore how peer learning can enhance students’ understanding of Computer-Aided Design (CAD) and empower them to be more motivated with the AutoCAD program for interior design students. **Scott Chin** shares the obstacles to online teaching, moving from the initial resistance to online education to its immediate fusion within education in the face of the global pandemic. **Markus Wernli** explores co-crafting as coursework, applying the notion of recursive publics to adult learning and eco-friendly activation that aim to engage diverse learner groups to promote wellbeing and a healthy environment. **Anneli Giencke’s** photo essay links design education to the vertical studio formula as a method to advance peer-to-peer education practices in the digital era. In comparison, **Michael Chan’s** photographic essay reflects on service-learning, and his award winning cross-disciplinary hands-on design build model. Finally, **Aruna Ventaktesh**, a PhD student, discusses tacit knowledge and the blended learning studio environment in the assimilation of creativity.

In conclusion, when taking a broader view, the link between design and design education becomes inseparable. Transformations in design will always change design education’s goals. Moreover, design education is not only an enabling compass for project development. In parallel, it reveals viable ways of nurturing individuals into becoming responsible students, effective designers, and furthermore, better citizens.

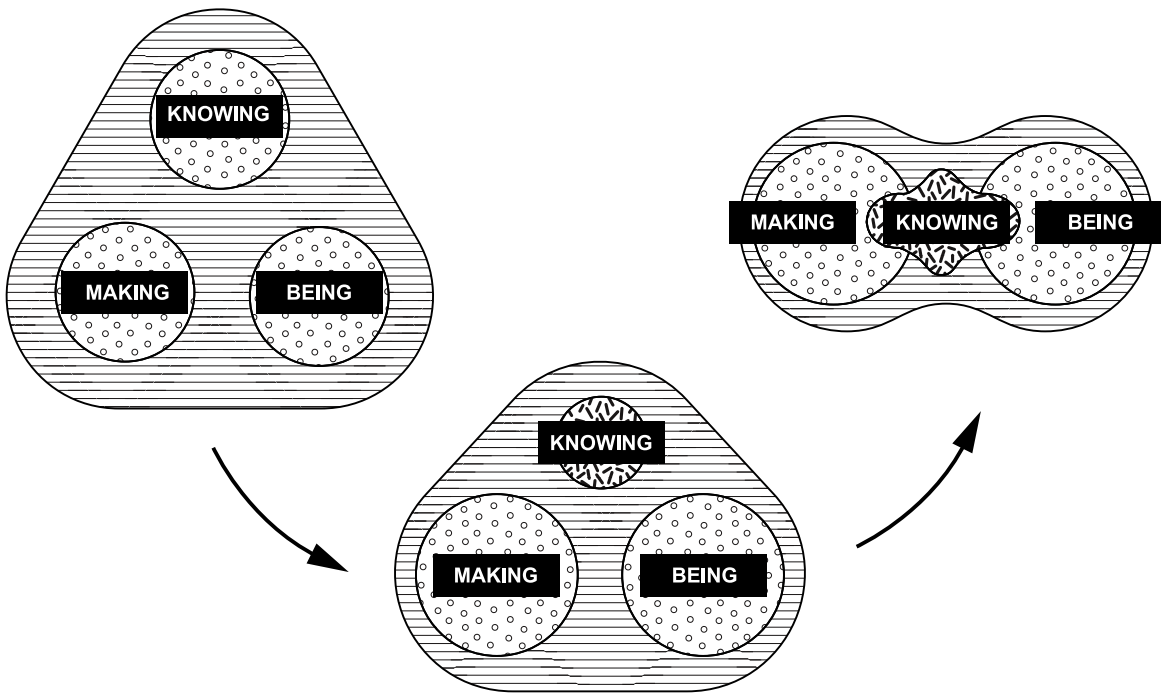


Figure 1: Evolution of Design Teaching: integrating competencies and meta-competencies. Department of Design, Politecnico di Milano's educational models on the left hand side, with authors' revision of

how knowledge, making and being has transformed within the current educational model. (upper right hand side of the scheme).

Source: authors

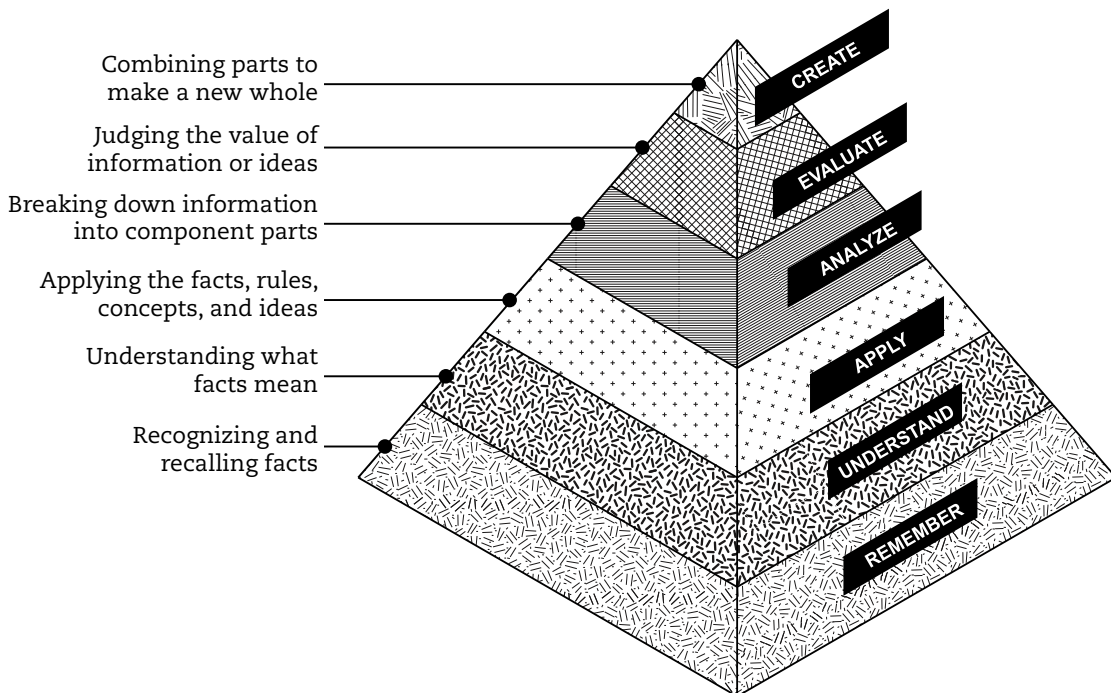


Figure 2: Bloom's taxonomy. Adaptation from Bloom (1956)

Notes

1. In 1956, Benjamin Bloom, along with collaborators Max Englehart, Edward Furst, Walter Hill, and David Krathwohl, published a framework for categorizing educational goals: Taxonomy of Educational Objectives. Generally this is known as Bloom's Taxonomy.

2. See also <https://cft.vanderbilt.edu/guides-sub-pages/blooms-taxonomy/>.

3. See <https://scuolaholden.it/en/holden-studios/>. Last accessed August 2020.

4. See <https://www.openideo.com>. Last accessed August 2020.

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Bio

Dr. Jae-Eun Oh is an assistant professor and a program leader for BA (Hons) in Digital Media at the School of Design, The Hong Kong Polytechnic University. She received an MFA from the School of TV, Film and Media Department, UCLA (University of California, Los Angeles) and a Doctorate from Department of Film, Performance, and Animation, Sejong University, South Korea. Before moving to Hong Kong, she has held teaching positions in South Korea and Singapore in higher educational institutes. Her research interests lie primarily in the area of animation storytelling, theme park attractions where they adopt animation content to attract visitors and animation nostalgia. Besides animation related research field, another research area of hers demonstrates how to motivate creative media students in the studio/project-based learning where they learn to create their media artefacts. She is a recipient of a Massive Online Open Course fund (HKD \$1million) Design Thinking in collaboration with Dr. Henry Ma.

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