INTERNATIONAL CONFERENCE ON ENGINEERING AND PRODUCT DESIGN EDUCATION
9-10 SEPTEMBER 2021, VIA DESIGN, VIA UNIVERSITY COLLEGE, HERNING, DENMARK

DESIGN AND CREATIVITY FOR DEVELOPING DIGITAL MATURITY SKILLS

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ABSTRACT
The emerging technologies of our century - such as Artificial Intelligence, Machine Learning, IoT, Virtual Reality, etc.. - are transforming the industrial economy requiring companies to start a process of digitalisation and transformation toward Digital Maturity. One of the main obstacles to digital development initiatives is the company cultural level and the identification of adequate digital talent with the right skills to manage digital innovations. Design and Engineering education has a key role in the development of such skills. They urgently need to co-evolve with the human, technological, and cultural evolution of the digital era we are facing.
The paper aims to present the theoretical DC4DM model that integrates the skills identified as in line with Digitally Mature companies' needs and, therefore, relevant for training cross-functional teams of future digital talents. Indeed, an important part of innovation success is the individual and team's creative abilities when designing for digital innovations.
New teaching methods and practices should be developed in design and engineering education considering the evolving and emerging needs of students and industry, addressing the development of the new set of skills and training future "digital wise" professional that can drive the Digital Maturity.

Keywords: Digital creative abilities, digital maturity, individual creativity, cross-functional team creativity, training box

1 INTRODUCTION

The influence of digital technology on companies' complexity has reached its acme in the last decades, with technological innovations directly acting on strategy, anticipation, and sustainability.
The emerging technologies of our century - such as Artificial Intelligence, Machine Learning, IoT, Virtual Reality, etc. - are transforming the industrial economy requiring companies to start a process of digitalisation and transformation toward Digital Maturity.
Only 1 out of 5 companies across the EU are highly digitalised, where around 60% of large industries and more than 90% of SMEs lag in digital innovation. Only 14% of Italian companies have a good level of digitalisation, 49% are laying the foundations for digital process management, while about 37% are in an initial phase of digital transformation. The gap between small and large companies is marked, as 70% of the latter have a defined development plan and have introduced innovative technologies within the company (EY Digital Manufacturing Maturity Index, 2019).
In this context, the NextGenerationEU will be dedicated to supporting the transition towards more sustainable and resilient economies and societies, ensuring that technology serves people and adds value to their daily lives. Digital technologies and digitalisation processes are in fact recognised as a key enabler for achieving the UN Sustainable Development Goals for a sustainable, inclusive, and better future for all.
The spread of digital technologies within organisations is having a massive impact on the type of skills needed by their employees. By 2025, at least 50% of employees will need to have digital skills as well as human skills such as complex problem solving, strategic and creative thinking, critical thinking, emotional intelligence, communication and negotiation, relationship, and network building abilities [1].
Indeed, one of the main obstacles to digital development initiatives is the company cultural level and the identification of adequate digital talent with the right skills to manage digital innovations.
Design and Engineering education have a key role in the development of such skills. They urgently need to co-evolve with the human, technological, and cultural evolution of the digital era we are facing.

New teaching methods and practices should be developed considering the evolving and emerging needs of students and industry to address developing the new set of skills and train future "digital wise" professionals that can drive Digital Maturity.
This is the main objective of the Erasmus+ project, "Digital Creativity for developing Digital Maturity future skills". The project aims to implement and spread an educational box called DC4DM Edu Box with the right tools and methods train cross-functional teams of design, engineer, business students to face the complex real-world challenges brought by digital transformation. The box empowers Digital Creativity that refer to the human ability to create an innovative and original digital outcome strategically exploiting the opportunity of digital technologies [2].
The paper aims to present the theoretical DC4DM model on which the Edu Box will be built. The DC4DM model indeed integrates all the Digital Creativity skills identified as in line with Digitally Mature companies' needs and therefore relevant for training future digital talents.
The paper briefly presents the first configuration of the model that, thanks to co-design actions within the Erasmus+ project consortium, have been implemented, evolved, and adequately described in its new shape in section 3.

2 FIRST CONFIGURATION OF THE DC4DM MODEL

The DC4DM model has been developed considering the main Digitally Mature company's needs [3] that have to i) strategically apply digital technologies to develop new business, to digitalise operation and processes ii) face complex challenges that require the knowledge of employees with different functions, that should work together also remotely on collaborative digital platform iii) face future sustainable and social challenges, planning long term strategies to be competitive even in an uncertain future.
For each identified need, the model integrates the specific set of skills defined as Digital Creative Abilities (DCA) that empower people to express their creative potential and think and act in a non-predictable digital world. The model has, therefore the aim to enable and empower students in:

- acquiring competencies and mindset to understand the potentialities of digital technologies and apply them to design digital solutions with a human-centred approach.
- developing individual abilities of creative self-enhancement, and a digitally-minded culture, as well as the team ability to communicate and share knowledge with others with a different background.
- acquiring skills in future and anticipatory thinking, developing a mindset that can generate a long-term strategic vision and help companies face complex challenges by envisioning future scenarios.

Digital talents should be prepared to face the diversity of uncertain futures, anticipate possible scenarios, and take full advantage of the innovation capacity of digital technologies.

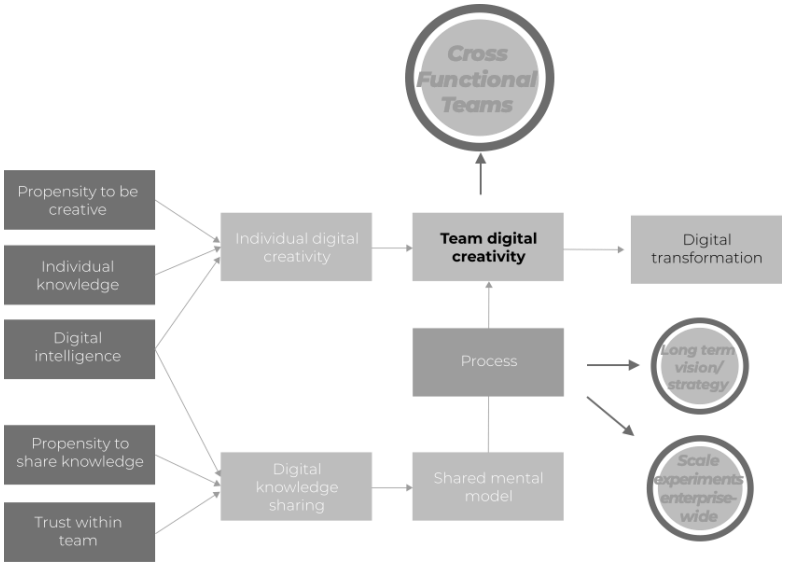

Figure 1. First version of the DC4DM model.

Within the model, the Digital Creative Abilities are structured along four main dimensions: i) individual creativity that includes an individual's propensity to be creative, meaning the cognitive, motivational,

attitudinal, knowledge and emotional abilities fundamental for individual creative empowerment. It also includes individual knowledge ii) team knowledge sharing, meaning an individual's propensity to share knowledge and trust within the team that includes social and emotional abilities and dynamics to empower winning cross-functional teams iii) Digital Intelligence, that affect both the previous individual and team dimensions and includes the ability to acquire and apply new knowledge and skills related to digital technologies, to improve operational efficiency and outcomes quality [4] iv) process, including the ability to analyse driving forces to map possible alternative scenarios, and to solve problems/challenges strategically.
The complexity of the model is evident considering that it needs to be transferred to educators, learners, and companies immediately and straightforwardly. Thanks to co-design actions pursued with around 20 people amongst educators, researchers, and designers within the DC4DM project consortium, important consideration emerged that sparked reflections on implementing the model. The four primary reviews that have determined a turning point for the model are i) simplify the reading of information within the model, providing a sequential order of skills to be developed concerning the highlighted dimensions ii) highlight the importance of the process as a central ability that allows people to understand and strategically apply the potentialities of digital technologies and generate innovative solutions iii) integrate a dimension, currently not present, which encompasses the social, environmental and ethical responsibility skills as well as a future mindset that are relevant when developing a strategic vision of the future iv) highlight the importance of a circular and growth learning.
Based on this consideration, a new model configuration has been proposed, presented in the next section.

3 DC4DM MODEL: A NEW SKILLS ORGANISATION

Therefore, a new model configuration has been developed, considering the reflections that emerged during the co-design workshop. The main implementation has been done to reorganise the skills within the model, providing a sequence in the skills empowerment and simplifying the adoption and use of the model itself. Indeed, the model should empower cross-functional teams of students to creatively and strategically solve challenges exploiting the opportunities provided by digital technologies.
Therefore, the first step was to reorganise the model dimensions considering the *process* dimension at the base and as central to the model. The other dimensions precede and follow the process. In this way, the model has been divided in three sequential phases:

- *Pre-process:* this part of the model includes the knowledge and skills that are propaedeutic to the process and that are needed by cross-functional teams to go through the process. The pre-process consists of the individual digital creativity dimension and digital knowledge sharing, and the operational knowledge required to work with digital tools and collaborative platform. These become, therefore, antecedents of the model.
- *Process:* the design process is based on a creative and design thinking process that generates innovative ideas. It is a divergent and convergent process deconstructed in stages, steps, activities and thinking style. For each step of the process, specific digital creative abilities intervene that are responsible for the originality of the output and both the individual and team performances during the process. The tool developed to empower and train the model is the Digital Creativity Framework that maps the factors that intervene in a specific moment of the process and allows to define design actions and tools to empower it, enhancing the factors. The framework allowed to map the less rationale creativity factors emphasising their interconnections with the different steps and activity of the process.
- *Post-process:* in this third phase, the team has finally reached a shared mental model and a knowledge structures – related to equipment and tools, task, goals, other members' skills, expertise and abilities, appropriate team interactions - that are shared among team members. This part of the model includes the skills that allow to create continuous learning cycles to further develop and nurture the skills they acquire, continue to learn, and scale the skills to other people within the organisation. These post-process skills will help people to iterate and continue to add value to their abilities to the organisation they are part of and the system.

Another important implementation is integrating some relevant knowledge and skills that have been considered fundamental and missing in the previous configuration. These can be regarded as transversal to the three phases becoming the pillars on which the model is based. A new dimension called "Digital Sustainability and Responsibility" has been added that includes the future, ethical and sustainable thinking skills considered relevant when dealing with uncertain digital futures.

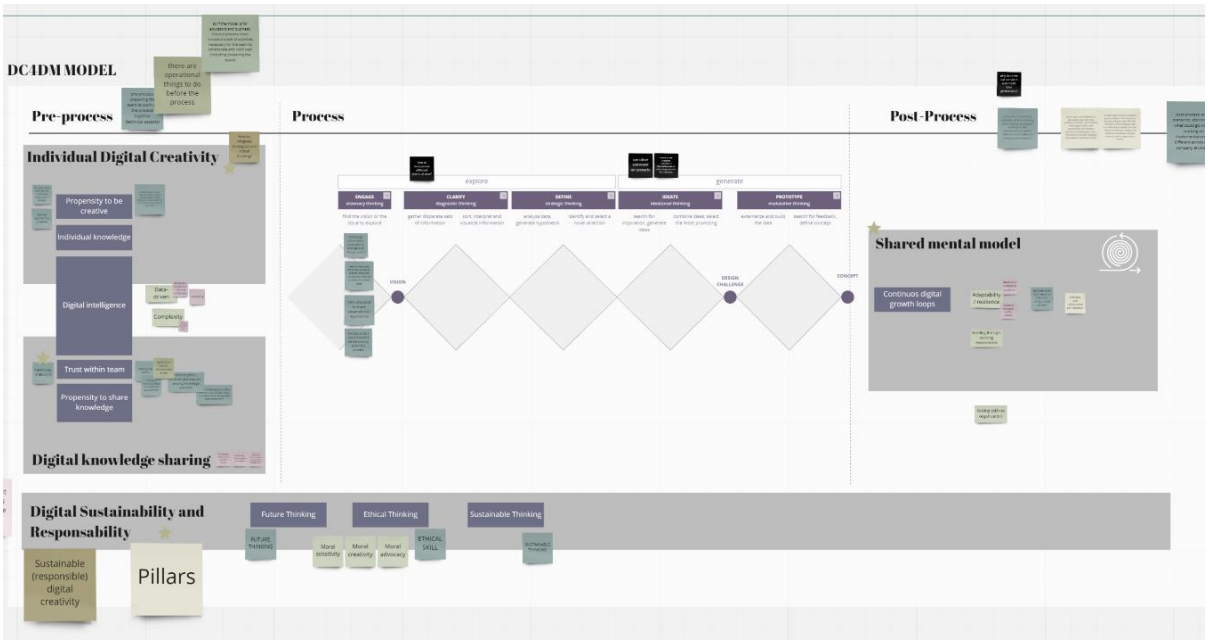

Figure 2. A new skills organisation defined during a consortium co-design workshop.

The next section focuses on the pre-process phase, highlighting and describing the main dimensions that have been included and integrated in this new starting phase of the model.

4 PRE-PROCESSES: FROM INDIVIDUAL TO TEAM CREATIVITY A SEQUENTIAL APPROACH TO LEARNING

Intervening in a group's creativity training implies considering team composition, namely its number of members and personalities. Thus, members bring the group their related backgrounds, experiences, and professional aspects and their traits and social characteristics. Then, team climate is based on collaboration; this is not immediate and needs to be built around the process of working together. Finally, the external environment can influence interactions amongst members and their performance during task fulfilment.

The concept of team creativity is strictly related to its individual dimension, as the collective process is composed of participants with their unique characteristics that they share and blend during the collaboration. To support team creativity, it needs to consider individual members' creative personalities [5], to examine how the team produces ideas starting from individual creativity, considered as input factors, based on the assumption that the innovation process initially came from the individual. Individual creativity is the fundamental resource that each group participant makes available for the collective, with the purpose of its combination and integration to address the project problem-solving. Consequently, the blending of team members' personality with their embedded aspect as creativity constitutes a collective resource [5].

Team creativity results from both individual creative personality and the pooled resources that team participants make available to others [5]. Team creativity is considered a synergetic progression that occurs during a social process of sense-making and collaboration. One individual's actions may inspire the team to devise, thus following a more creative strategy to address the problem [6]. The result of this phenomenon is higher levels of creativity because team members become exposed to divergent information and opinions and a variety of unusual ideas that may have a beneficial effect on individual creativity. Individuals' contributions provide the team with its "raw material" [4]. However, team creativity is more than the combined individual creativity of team members; other factors influence the contribution of each member and the interaction among the group.

Creativity can be fostered in teamwork due to the inclusion of diversity in team members' roles [5]. Indeed, this heterogeneity can affect creative thinking amongst the group through the exposure of team participants to a wider variety of unusual ideas [7]. Diversity in team members is related to their background, openness to others' ideas, constructive collaboration, communication, and commitment to

the project. Namely, a group that includes diversity embraces the idea of cross-functional collaboration to increase performance in terms of improving the opportunities for creativity to occur.
Therefore, two main dimensions contributing to team creativity are preconditioned in the education before moving on to the process. The former is the individual sphere, while the latter is the collective sphere that occurs when members interact within the teamwork. Individual creativity leads to group creativity.

4.1 Individual Digital Creativity: the individual dimensions

This first dimension includes the DCAs, which allows the individual contribution that provides the team with its raw material to start and iterate the process of team creativity. It comprises three main elements, each one defined by specific DCAs. According to Boughzala (2020) [4], the first element to consider in the pre-process phase is an individual's *propensity to be creative*, defined by personal ability, personality, motivational variables, and cognitive process that anticipate and result in individual creativity. It also involves skill sets that encourage creativity and the ability to remember a large amount of information accurately to recall it when needed to improve the capability to create links between different and ideas to solve problems. As a result, individual knowledge is the second element that contributes to building individual creativity. *Individual knowledge* is the basic raw material and the foundation for all creative work. It refers both to the factual knowledge about a problematic phenomenon and technical skills for specific procedures. The third element is *digital intelligence* meaning the ability to acquire and apply new knowledge and skills related to digital technologies to improve operational efficiency and outcomes quality. This element is also relevant for the Digital Knowledge sharing dimension.

4.2 Digital knowledge sharing: the collective dimensions

The second collective dimension is composed of the propensity to share knowledge in a group setting and the trust between members during teamwork. Combining these two elements contributes to the knowledge sharing practice needed to build a shared mental model among team participants, it is useful to create a common language that enables more creative interactions. Considering that the model was created to train DCAs in cross-functional teams as an essential key to achieving DM, it is necessary to consider the specific characteristics of this type of team before describing the two elements that constitute digital knowledge sharing.
A cross-functional team needs to include proactive employees who can work well independently and in the group dimension [8]. Cross-functional teams benefit from the unique mix of skills and talents each member brings to the project. Thus, working in a group context of information exchange and skills integration is the basement on which is possible to build additional foundational elements that need to be proper of a cross-functional team member. Indeed, when team members understand their role in the process, they are more prone to work cross-functionally with others to achieve the goal.
The team is mainly influenced by trust within members, the propensity to participate and share knowledge of the participant and the willingness to integrate the knowledge shared into a common language for the group building shared mental models.
The propensity to share knowledge is a crucial aspect of teamwork because it is the condition that allows a member to actively take part in group collaboration with his or her knowledge and expertise. It is necessary to explain what knowledge sharing represents to understand its importance better. It is a practice that occurs when team members spontaneously and actively exchange information and expertise to reach a broader understanding of the problem. It is a critical aspect for a creative team because it incorporates individual-level knowledge into team one is to solve problems and complete tasks for the related project. More information from multiple and diverse sources provides the group with a wider range of notions and perspectives that enlarge the possibility of creating new and innovative ideas.
Consequently, being willing to share is the base to collaborate efficiently in a team setting. Trust influences how knowledge is shared, viewed, and integrated by team members. Team trust, in its essence, represents the predictive understanding of another's behaviour. Trust is the basement of teamwork, thus of cross-functional collaboration. Indeed, Sinek stated that "a team is not a group of people who work together, a team is a group of people who trust each other". If team members feel safe in the team environment, they are prone to interact with each other. A high level of trust leads to higher levels of productivity and effectiveness (Forbes, 2019), due to the encouragement of questioning among members that leads to better decision making. In addition, trust benefits interpersonal relations minimising misunderstandings and conflicts, consequently improving communication. The most

important factor in guiding team success is to build psychological safety amongst members through trust. Team workers need to feel safe and vulnerable in front of others to be able to take risks. As introduced before, trust embeds the willingness to be vulnerable in terms of having positive expectations about the behaviour of the other group members and eagerness to rely on others [9] as a basement to guide and stimulate a risk-taking attitude.

5 REFLECTION AND FUTURE ACTION

The paper presents and discusses the integrated DC4DM theoretical model to develop creative and strategic skills that future digital talents should develop to design and innovate in cross-functional teams. The main point regarding the concept of cross-functional teams is its peculiar composition of members from different functional background of the organisation. This aspect is defined as functional diversity. It consists of the differences amongst individuals in knowledge, skills and abilities, values, beliefs, attitude, personality, and cognitive and behavioural style [10]. Therefore, an essential phase of the model – the pre-process phase - is dedicated to highlighting and giving values to the individual differences and training people in understanding how to integrate those differences to achieve successful results during the consequent process phase. The DC4DM model represents the theoretical model of skills translated in educational training methods, activities, and tools for design, management, and engineering students. The theoretical model will become an action model, namely DC4DM Edu Box, that will include educational and innovative resources to develop the right skills to drive companies toward Digital Maturity. However, the complexity and the abundance of skills included in the model, makes difficult the integration of learning resources dedicated to empowering each skill. Therefore, future activities will be dedicated to identifying and select a specific and fewer set of skills within the three consequent phases and to develop specific educational resources for them that will be part of the final Edu Box addressed to both educators and students.

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