original research article
UDC xxx

admission date 03 11 2025
approval date 16 12 2025

NAVIGATING COMPLEXITY IN DESIGN EDUCATION: A HOLISTIC PEDAGOGICAL APPROACH WITH THE DESIGN CHALLENGE NAVIGATOR

ABSTRACT

Contemporary design education faces the challenge of equipping professionals to navigate increasingly complex innovation problems. While design thinking, systems thinking, and agile methodologies are each established in education, they are seldom systematically combined to address socio-technical challenges coherently. To address this gap, we present the Design Challenge Navigator (DCN), an educational toolkit designed to help learners critically assess complexity, structure their design processes, and build competencies for sustainable, user-centred interventions. Grounded in a holistic pedagogical approach, the DCN supports future designers in integrating iterative development, stakeholder participation, and systems awareness. To examine its relevance and transferability, we gather insights from coaches and educators who apply the DCN across varied educational environments. By analysing their perspectives, this research contributes to design education, demonstrating how integrated, practice-oriented tools can enhance interdisciplinary learning and prepare future professionals for complex, sustainability-oriented innovation challenges.

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KEY WORDS
DESIGN EDUCATION
DESIGN THINKING
SYSTEMS THINKING
LEARNING MATERIALS

1. INTRODUCTION

Solving complex design problems is inherent to the domains of design and innovation. It is therefore not surprising that understanding the underlying creative processes and searching for efficient and effective methods of problem solving is not uncharted territory in these domains. From Horst Rittel and Melvin Webber's groundbreaking contribution "Dilemmas in a General Theory of Planning" (Rittel & Webber, 1973) to Nigel Cross's "Designerly Ways of Knowing" (Cross, 2006) or Tim Brown's "Change by Design" (2009): the list of those who have analysed the approach to solving complex design problems and have developed applicable methods for their effective solving is long.

In the current field of design and innovation, design thinking has become an established method for the exploratory and iterative development of human-centred products and services, as well as business models. Design thinking is nowadays also widely taught and applied at business schools as a method for tackling complex business challenges (Lattemann et al., 2020). However, as the method became more widespread, its limitations also became more apparent, and design thinking, originally hailed as the "next big thing" (Ideo.com, 2025), has lost some of its original glory. There are references indicating that its implementation in universities and businesses is not without pitfalls (Sparwald, 2022; Freudenthaler-Mayrhofer & Sposato, 2017). Other authors argue that the strength of design thinking lies more in psychologically empowering participants than in providing a blueprint for solving complex problems (Roth et al., 2022). However, future professionals must be given the skills they need to solve complex problems, since the landscape of current challenges is no longer characterised solely by problems that can be more or less clearly delineated from one another, but rather by intertwined complex issues such as the environmental crisis, increasing disinformation, rapidly advancing technologies, and demographic changes (Jones & Ael, 2022; Statista Research Department, 2024). Modern challenges appear on a socio-technical spectrum. Solutions of different orders can tackle such challenges. While designing artefacts, products, or services as a solution to a given challenge is comparably limited in its complexity, changing organisational

structures, or pushing social transformation and policymaking are more complex endeavours (Buchanan, 1992; Jones & Ael, 2022). Unfortunately, in many cases, designer training still does not adequately prepare them for the complexity of the innovation challenges they will face (Kretschmer, 2014). However, tackling design challenges, especially more complex ones, has long since ceased to be the sole responsibility of a single domain. In fact, complex design and innovation challenges nowadays require interdisciplinary and transdisciplinary collaboration. The level of expertise in applying processes and methods, however, often varies considerably across different domains. Particularly in the context of adult education (e.g. MA, Executive MBA), where students with widely differing backgrounds regularly work together, this can pose a significant hurdle to successful teamwork. It is therefore essential to adopt systematic, practice-oriented approaches to training to enable future professionals to tackle the full range of current and future challenges in design and innovation.

There are structured and relatively easy-to-use toolkits for defined aspects of innovation processes (and for defined domains) that can be used to master innovation challenges. For the development of business models, for example, there is the Business Model Navigator, developed primarily at the University of St. Gallen (businessmodelnavigator.com). Its goal is to foster business model innovation via a structured approach. From the field of design, specifically from ideo, one of the largest design agencies globally, comes designkit (designkit.org). With the help of tried-and-tested methods, it aims to make the user-centred design approach as easy to apply as possible. And when it comes to implementing eco- or sustainable design principles in product design, a variety of toolkits and method kits are available. Examples include the Sustainable Design Cards from the Design School Kolding (sustainabledesigncards.dk) and the ecodesignkit from the German Federal Environment Agency (ecodesignkit.de). These examples are representative of a range of other available tools and method kits of varying designs and user orientations.

However, there appears to be a gap in tools that are easy to use, even for inexperienced users, and which:

- address innovation challenges as holistic problems rather than from the perspective of individual domains.
- are methodically sound and easy to understand, guiding users along defined but also flexible paths to solutions.
- are capable of addressing all degrees of complexity of innovation challenges equally, including systemic challenges.

All these aspects are important for innovation training, and it seems that there is no educational toolset that reflects this. In response to these educational challenges, the Design Challenge Navigator (DCN) has been developed in collaboration of four European universities during the sUser project funded by Erasmus+. The DCN is an educational toolkit developed to help learners critically assess complexity, structure their design processes, and build competencies for sustainable, user-centred interventions. Its core concept and key features are briefly described subsequently. The analysis in this paper then draws on the practical application of the DCN by coaches and educators across varied educational environments. The focus is on gaining a better understanding of how DCN is used in practice and what advantages and disadvantages its use can entail. In the cases referred to for this analysis, the DCN was applied both in short-term learning environments as well as in projects that lasted up to several weeks.

2. TACKLING COMPLEX CHALLENGES WITH THE DESIGN CHALLENGE NAVIGATOR

The DCN is an educational toolkit. It is available both in physical form, based on the concept of classic board or card games, and in purely digital form, which enables online collaboration. It aims to systematise and facilitate the tackling of complex design challenges in design and innovation education, thereby making them more manageable.

2.1. Four Degrees of Complexity

Design challenges are inherently difficult to solve, and upon closer inspection, some challenges turn out to be quite complex endeavours, or even highly complex problems at a system level. For example, many of the current issues we face as societies fall into that category and are inherently "wicked" (Kolko, 2012). The term "wicked problems" characterises challenges that have no definitive formulation and therefore can´t be ultimately fixed; however, not properly addressing them results in negative consequences for society (Rittel & Webber, 1973). This requires continuous adaptation to changing conditions when finding solutions. Of course, not all design problems are so complex in nature. Traditionally, simpler and more graspable design tasks will always remain (Swanson, 2020).

TABLE 1. Four degrees of innovation challenges based on Meyer and Norman (2020).

Challenge Type	*Characteristics*	*Examples*
1st Degree	Challenges that require advanced professional skills.	• Creating a low-complex product for a very specific customer segment • Developing an advanced technological product
2nd Degree	Challenges that require dealing with the entire system and applying technical skills to this system.	• Developing advanced technological product or machinery plants or services that are experienced differently depending on the user group
3rd Degree	Challenges dealing with more complex systems that are strongly influenced by their surroundings, environment, local culture and political concerns.	• Developing systemic solutions for health care and the demographic shift • Developing systems for communities of different cultures
4th Degree	Challenges that require the processing of complex socio-technical systems.	• Challenges related to the Sustainable Development Goals

The DCN is intended to provide assistance in tackling this variety of design challenges, particularly for less experienced users, thanks to its ease of use. Depending on the complexity of the challenge, the DCN therefore initially distinguishes between two processes with a total of four different degrees of complexity. After initially defining the identified problem, seven criteria are used to assess the degree of complexity involved.

2.2. Different Approaches for different Degrees of Complexity

Understanding abstract concepts is easier when using familiar analogies we've experienced firsthand. The DCN uses such analogies by deliberately paralleling leisurely hikes and adventurous expeditions – just as an innovation challenge can be less complex or highly challenging (see Table 1).

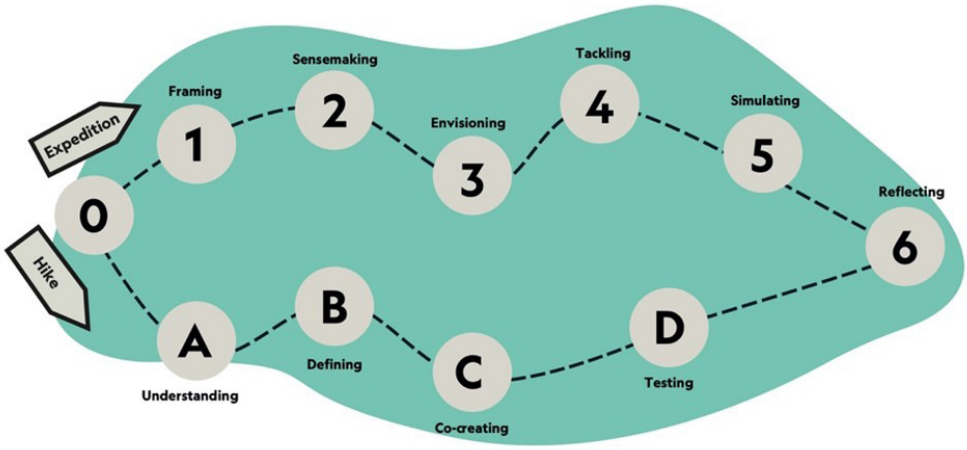

FIGURE 1. Design Challenge Navigator offers two processes

Literally everyone has been on a hike, and most of us probably have at least some idea of the challenges inherent to an expedition – some may even have mastered one. With the right strategy and equipment, hikes on low, grassy hills can usually be conquered without too much effort. It may not be easy, but we know how to do it. But of course, there are also moderately difficult hikes. At the other end of the spectrum are expeditions to 'rocky monsters', fearsome rock formations that perhaps no one has ever climbed before. Here, we have no choice but to face uncertainty, try out strategies and experiment. The success of our endeavour remains highly uncertain here – working with highly complex issues is therefore much more like an expedition than a hike. But of course, some expeditions are not quite as demanding. Depending on the complexity level of the innovation challenge, the DCN therefore offers two different processes: "hikes" and "expeditions" (see Table 2).

2.3. Navigation Map

The *Navigation Map* is the central component of the DCN. This is where the methods chosen by students during their innovation journey are placed, and the design process is built step by step. To create an analogy, we have illustrated challenges of varying complexity with mountains of varying difficulty. Just as one cannot climb every mountain with the same equipment and approach, one cannot tackle every challenge with the same methodology and tools. A lower mountain (1st and 2nd degree challenges - "hikes") and a higher, steeper mountain (3rd and 4th degree challenges - "expeditions") are shown on the navigation map. The respective processes are marked along a route of the respective mountains. Along each process step, the trainees have placeholders for cards where they can place the methods used in the respective step.

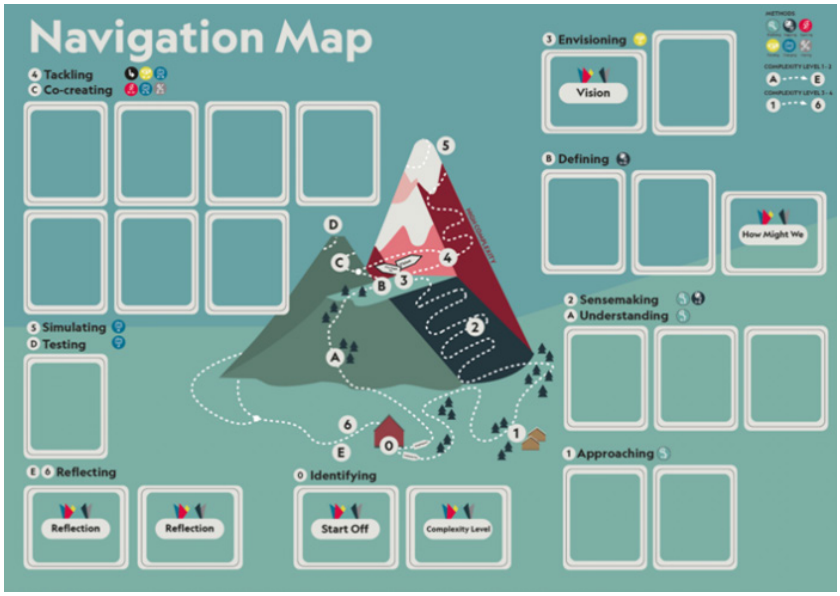

FIGURE 2. The Navigation Map enables students to build their innovation journey

2.4. Method Cards

The DCN offers a total of 40 method cards. Each card contains a brief description of the method, a step-by-step implementation guide, an overview of the time required to apply the method, the human and material resources

required, and a recommendation on which methods could be implemented before and after. Furthermore, the cards provide an assessment of whether the method is more suitable for the "hikes" or the "expeditions". Generally, the methods are divided into the following six groups: *Exploring*, *Mapping*, *Sparking*, *Changing* and *Tackling*.

TABLE 2. Overview of method types (Source: Authors' own creation).

Method type	*Explanation*	*Selected methods*
Exploring	Methods that are suitable for collecting information	Trend analysis, contextual interviews, service safari
Mapping	Methods that are suitable for visualizing and clustering information to make sense of it	Actors map, affinity diagram, persona, location mapping
Futuring	Methods that assist in envisioning an alternative future	Three horizons, design fiction, system value proposition
Sparking	Methods that are suitable for gathering inspiration, generating and selecting ideas	Analogies, brainwriting, biomimicry, dot voting
Changing	Methods that assist in creating and testing a sustainable solution	Leverage strategy, design for behavioural change, living labs
Making	Methods that are suitable to prototype or visualize an idea	Sketching, paper prototype, digital mock-up

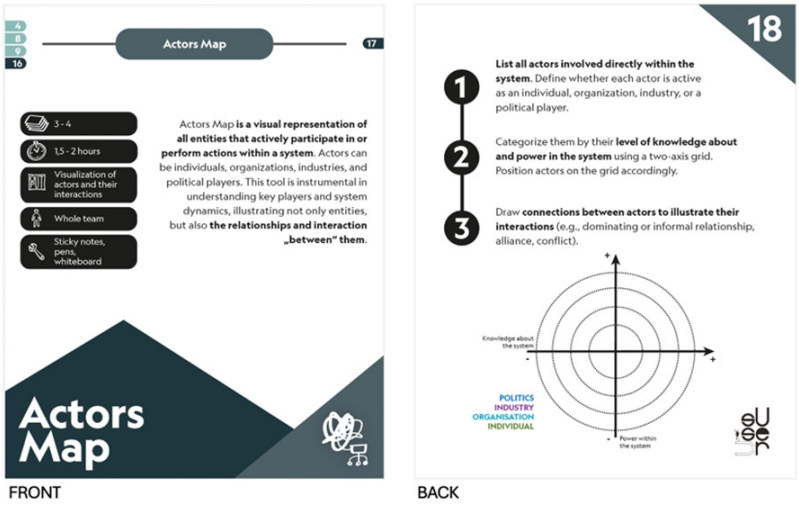

FIGURE 3. The DCN offers a selection of 40 methods enabling students to navigate through challenges of different complexity.

2.5. Statement Cards

Statement cards are writable cards that encourage the innovation team to discuss and reach an agreement at certain points in their process. There are five types of statement cards: *Start Off*, *Complexity Level*, *How Might We Statement*, *Vision Statement* and *Reflection*.

TABLE 3. Overview of statement cards (Source: Authors' own creation).

Statement card	*Explanation*
Start Off	The *Start Off* card asks the innovation team to formulate their innovation challenge in one sentence based on the project briefing they have got
Complexity Level	The *Complexity Level* asks the innovation team to determine the level of complexity by rating seven questions on a scale from "low" to "high" based on the knowledge they currently have.
How Might We	The *How Might We* statement builds the foundation of their idea generation on lower complexity levels.
Vision	The *Vision* statement builds the foundation for envisioning a preferred future on higher complexity levels.
Reflection	At the end of their Innovation Journey, *Reflection* cards should encourage the innovation team to self-critically scrutinize both their innovation process and their solution and to openly address any weaknesses.

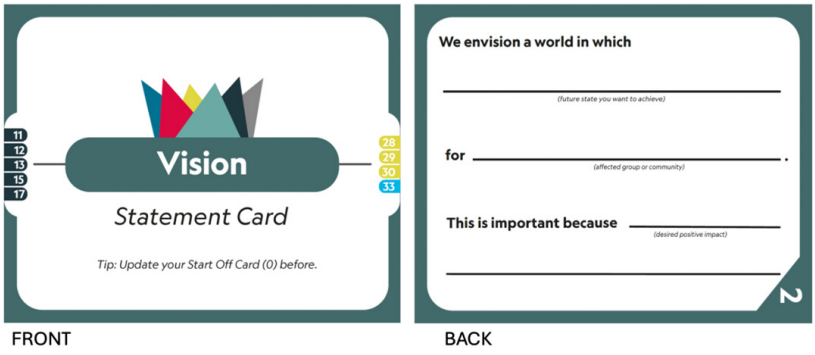

FIGURE 4. Example of a statement card (Source: Authors' own creation).

2.6. Navigator

Within the innovation team, there must be agreement on when a process step is complete, and the next phase can begin. To facilitate this discussion, we introduced the *Navigator* - a playing figure that is moved to the next process step on the navigation map after each step is completed.

3. PRACTICAL APPLICATIONS OF THE DCN

Over the past year, the DCN has been applied and tested in various educational settings across several European universities. To examine its use in practice, data were collected from six educators at European universities through an online questionnaire with open-ended questions (see Attachment 1). The dataset comprises seven cases that differ in duration, application context, and the intended use of the DCN. Table 4 provides an overview of the collected cases.

TABLE 4. Overview of the DCN applications (Source: Authors' own creation).

Case	*Context*	*Duration*	*No. of participants*	*Educator code*	*Purpose*
Case 1	Disruptive event workshop	3 hours	29	A	Inspire to use *Making* & *Changing* cards
Case 2	Public space redesign	2 hours	8	A	Create a design or research plan
Case 3	Biobased materials in build environment	3 workshops	12	B	Create a research plan with more unconventional methods
Case 4	Innovation project (service design)	2,5 months	15	C, D	Introduce a structured approach to innovation projects
Case 5	Design project	1,5 months	14	E	Structure the early phases of a design process
Case 6	Innovation project (service design)	3 days	14	D	Introduce a structured approach to innovation projects
Case 7	Design for circular economy	1 – 3 months	18	F	Scaffold design process and support independent teamwork

Across the seven cases, two main dimensions characterising the applications became evident: purpose and learner experience. First, the DCN can be applied either as an inspirational tool in short formats (e.g., workshops) or as a process-guiding framework in extended courses. Second, applications differ between novice learners with limited design training and experienced learners who are already familiar with design thinking principles and processes.

The intersection of these dimensions results in four potential patterns of use (Table 5). Empirically, three of these patterns were represented in the collected data. There were no cases in which the DCN was used as an inspirational tool for novice students, as the format and structure of the material do not readily support this type of application.

TABLE 5. Overview of the DCN applications (Source: Authors' own creation).

Learner experience / Purpose	*Novice students*	*Experienced students*
Inspiration	-	Case 1 – 3
Process-guiding	Case 4 - 6	Case 7

3.1. DCN as inspiration for experienced students

Cases 1 to 3 illustrate the application of the DCN as an inspirational tool in short-term learning settings. In these cases, the DCN was used to broaden students' methodological repertoire and to support reflection on alternative approaches within the design process. All three applications were aimed at students who were already familiar with design thinking principles and process. Consequently, the DCN was not introduced as a comprehensive process framework but rather as a stimulus for exploring new ways of structuring or enriching existing project work.

In *Case 1*, the DCN was integrated into a three-hour workshop conducted as part of a *Disruptive Events* minor programme. The workshop focused on climate- and migration-related challenges and took place at the end of the semester. Students worked in groups using selected *Making* and *Changing* cards to develop ideas and refine their concepts.

In *Case 2*, the DCN within a two-hour interdisciplinary workshop on the redesign of public space. Students used the DCN canvas and card set to develop a concise design or research plan. Although the limited time frame required close facilitation, participants were able to work largely autonomously after a brief introduction. Despite the short duration, the DCN helped participants navigate their approach to the project more systematically. The educator A observed that "the DCN really helped the students to navigate their design approach a little bit more structured," and that the different methods "inspired them to think out of the box and try new things." The DCN instructions were not explained in either of these cases.

Case 3 illustrates how the DCN was employed in a series of three workshops within a course on *Biobased Materials in the Built Environment*. Here, the toolkit was used selectively to stimulate deeper exploration of material-related questions. Students had prior experience in material research but tended to use rather conventional or desk research methods. By introducing the DCN, the educator encouraged them to focus on one specific aspect of their projects and to combine different research techniques, such as interviews and material testing. As a result, students achieved a "more profound level

of knowledge about that material" and "broadened their research skills", as noted by educator B. Across these three cases, the DCN proved effective as a means of methodological inspiration and structured reflection. The short-term, exploratory use of the toolkit enabled students to approach familiar design challenges from new perspectives and to experiment with alternative methods.

3.2. DCN as a process-guiding tool for novice learners

Cases 4 to 6 demonstrate the application of the DCN as a process-guiding framework in courses aimed at students with limited prior knowledge of design methods. In these contexts, the DCN was used to guide learners step by step through a complete innovation process.

In *Case 4*, the DCN was integrated into a 2.5-month innovation project in the field of service design. The participating students had little experience with design processes. The course combined input from the educators and group work, with the DCN serving as the main framework for project execution. Students were guided through each stage of the process, and the educator pre-selected methods from the DCN cards that match the course objectives. For these methods, the educator provided additional supporting materials (e.g., in-depth explanation, examples). The educator C noted that "the students needed general guidance and received input at the beginning of each stage, such as preselecting the tools." As the course progressed, students began to understand "how an innovation project can be structured, and which stages are necessary to move from a problem to a tested result", as explained by educator D. The DCN thus supported both learning methods and process awareness. However, the educator also observed that beginners often felt overwhelmed by the large number of tools available and that several methods - particularly the Statement and Reflection cards - required additional attention.

In *Case 5*, the DCN was applied in a 1.5-month design project within a master's programme. Although participants had some familiarity with creative methods, their experience in applying structured design processes was limited. The DCN was used primarily to frame the *Understanding* and *Defining* phases. The educator provided an introductory session explaining the logic of the DCN. Once the process became familiar, the teams were able to work independently. According to educator E, "less experienced students in particular found it easier (and faster) to follow the process." The educator, however, identified a need for a clearer and more accessible tool to determine the appropriate complexity level for each project.

In *Case 6*, a three-day intensive *Innovation Bootcamp* was conducted with Executive MBA participants who were new to design but brought substantial professional experience from other domains. The DCN served as the main framework for project execution. After an input session on design thinking and introduction of the DCN, the rest of the work time was dedicated to group work with short input sessions on a particular phase and its methods. Participants selected their preferred tools after each input session and then debriefed them with the educator. The facilitator (educator D) observed that "even though students were new to the design discipline, they really appreciated the clear guidance of the navigator" and that "the process became clearer, and they could afterwards map which tools belong to which phase." The DCN thus enabled the participants to quickly gain an overview of the design process and to connect specific methods to distinct stages of problem solving.

Across all three novice cases, the DCN functioned as a pedagogical scaffold that helped learners externalise and manage the design process. It supported systematic progression, provided orientation, and built confidence in applying methods.

3.3. DCN as a process-guiding tool for experienced learners

Case 7 demonstrates how the DCN can also serve as a process-guiding framework for more experienced learners who already possess a basic understanding of design methods and processes. In this course on *Design for Circular Economy*, students worked once a week over a period of one to three months. The DCN was introduced at the beginning of the course to structure the overall design journey and to support independent teamwork.

The educator followed the design thinking process - drawing on the double-diamond and Stanford models - and integrated the DCN to guide the application of methods in each step. The toolkit was used both for group discussions and as a planning aid when choosing suitable methods for project phases. Educator F reported that the DCN "supported and helped students to go through the design process more structured, detailed and appropriate." The educator also noted that the DCN allowed them to "work more independently," reducing the need for continuous teacher supervision. At the same time, several participants commented that the logic of the complexity levels and some of the card descriptions required clarification and that a short face-to-face introduction was necessary for full comprehension.

4. DISCUSSION AND OUTLOOK

The cases presented in this paper demonstrate that the DCN can be effectively used both as an inspirational tool for experienced learners and as a process-guiding framework for novice or experienced student cohorts. Its flexible structure allows educators to tailor its use to different time frames and learning objectives - from short workshops to semester-long projects.

Across all implementations, two factors proved decisive for successful application: adequate preparation by the educator and a clear introduction to the DCN's underlying logic. Most educators choose to preselect methods to present to students, some even preparing additional materials on these methods to support the smoother implementation of the projects. In the longer projects where the DCN was used as a process-guiding tool, additional introduction of the DCN material was needed. However, while the DCN provides detailed materials, students rarely engaged with the written instructions or guidebook when a lecturer explained the process in person. This observation suggests that students rely primarily on educators' verbal and visual cues rather than on self-study of the materials.

In its present form, the DCN was tested before the release of the supporting digital videos and Miro templates. As a result, several educators called for clearer explanations, additional examples, and ready-to-use templates to simplify implementation - particularly for novice users. The new digital resources may therefore address many of these needs and further enhance independent use.

Overall, the DCN has shown to foster structured thinking, reflective practice, and methodological confidence among students. Short-term applications encourage creative exploration and method diversity, whereas long-term implementations build process literacy and autonomy, especially in multidisciplinary teams. As the analysed case studies show, the materials help address the previously identified gap by allowing users to tackle innovation challenges holistically rather than merely individually, guiding them through the process, and enabling them to address challenges at different levels of complexity. Yet for educators, successful use of the DCN depends on balancing structure and flexibility: providing sufficient guidance at the outset while allowing teams to navigate the process independently thereafter.

Although positive effects were observed across all DCN application cases, a long-term study with comparison groups (with and without DCN application) would be required to provide more detailed information about the longer-term impact of the DCN.

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NOTES

Attachment 1 – Questionnaire for educators

Context & background

- Which subject, course, or project did you use the Design Challenge Navigator (DCN) in?
- How long was the project or course where DCN was applied?
- How many participants were involved?
- How do you estimate the participants' experience with methods and design processes in comparable projects/courses (before using DCN)?
- How did you organise or teach this course/project before using the DCN?

Use of the DCN

- Which part of the DCN did you use?
  - At which level of complexity was the Project?
  - Which stages / process steps were applied in your context?
- How did you integrate the DCN into your teaching or coaching process?

Usability & support

- How independently were students able to use the DCN materials? Did they need continuous guidance, or could they work autonomously?
- How clear and understandable were the DCN instructions and materials? Did you need to provide additional resources or explanations? If yes, what and when?
  - If yes, what kind of materials or support did you add?

Learning effects & outcomes

- What were the most notable learning effects from using the DCN? (e.g., skills, mindset, Methods)
  - How do you estimate the output, improvement, engagement, passion, etc., etc…?
  - To what extent did students improve in handling complex, interdisciplinary challenges?
- Compared to previous iterations of the course (without DCN), how did outcomes differ? (in terms of Project results, collaboration, student Engagement, learning Outcomes)

Reflections and Future Improvements

- What worked particularly well with the DCN?
- What challenges did you face when using the DCN?
- What would you change or improve in the DCN or its implementation?

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