Design thinking teams and team innovation performance

Frode Heldal[1*]

*Correspondence:
*frode.heldal@ntnu.no

[1] NTNU Business School,
7491 Trondheim, Norway

Abstract

Design thinking (DT) is hailed as a cornerstone of innovation. It is based on teamwork, yet we know little about how the DT team operates and collaborates. In this study, we investigate 51 Norwegian master's student teams as they work on an innovation project using DT. We seek especially to understand how they communicate and collaborate while working with DT tools, with special attention to divergent and convergent thinking. Using a mixed methods approach, we analyze the teams´ behaviors and developments in these. Findings suggest that the highest performing groups use the DT method with greater discipline than the other groups. To achieve this, they employ more authority-based behaviors and fewer supportive behaviors than the other groups. This disciplined approach to DT as a process and the use of tools, such as brainstorming, are in turn associated with convergent and divergent thinking. The main conclusions are that a disciplined approach using DT as a team tool, enables team reflexivity and psychological safety. This enhances innovative performance.

Keywords: Design thinking, Innovation, Team performance, Psychological safety, Convergent/divergent thinking

Introduction

Design thinking (DT) is hailed as a cornerstone of innovation (Brown, 2009) and, by some, as an effective tool for innovation (Tschimmel, 2012). It can broadly be described as a creative problem-solving approach using a designer's perspective and including DT principles, mindsets, methods, and tools (Brown, 2008, 2009). A short overview of DT may be presented as follows (ibid.):

- What: A collaborative process to resolve creative and complex problems, suited for innovation processes.
- Principles: a series of stages that cycle through ideation, problem-solving, representation, and testing before returning to ideation once more to start a new cycle.
- Mindset(s): Rapid iterations between convergent and divergent thinking
- Tools: communication tools, visualization (design tools, such as sketches and drawings), brainstorming, and prototypes (minimum viable products).

Despite its popularity, the method has shown mixed results (Rao, et al., 2021). Some reason may stem from limited knowledge on the DT team. While DT is something of a buzzword, it may have been more popular in the domain of practice than in science (Meinel, et al., 2020). When we add the important modifier of teamwork, research on DT is even scarcer. Team DT is widely used and employed, but rarely researched. Collaborative DT has received relatively little attention in past research, and we know little about how collective intelligence operates in design (Lee, et al., 2020). The potential linkages between the literature on organizational and team learning and the tools and processes advocated by DT's collaborative emphasis represent a fertile area for inquiry (Liedtka, 2018).

The scope of our paper is thus to investigate how the DT team functions as a team, with specific attention to the dynamics between convergent and divergent thinking. Creativity emerges from the overlap between convergent and divergent thinking. Convergent thinking leads to a singularly appropriate solution, while divergent thinking produces multiple ideas and alternatives (Lee et al., 2020). Rao et al. (2021) claim that DT is a social technology of collaboration, and we will investigate how this technology works. Liedtka (2017) notes that DT as a social technology has rarely received attention from researchers. Our main issue with previous research on the DT team is that individual behaviors are aggregated to understand team behaviors, thus underrating the social. Although team creativity is logically dependent on individual creativity, team processes (e.g., internal communication, team cohesion, and vision) have been shown to be more important (Hülsheger, et al., 2009). Yet our current understanding of DT is that team creativity in a brainstorming session is achieved through all team members being creatively confident (see, e.g., Lee et al., (2020)), which tells us little about the above-mentioned team processes. Some point to the importance of maintaining a collaborative infrastructure (see, e.g., Liedtka, (2018)), but this tells us little about the perils at the team level when all individuals are collaborative and supportive (see Janis' concept of groupthink (Janis, 1982)). Finally, DT hails the importance of iterating between divergent and convergent thinking. This is hard for individuals but may actually be paradoxical at the team level (Heldal & Sjøvold, 2021).

Knowledge of team processes is important, because they may be at the very core of what makes DT function effectively or not. And as Rao et al., (2021, p. 2) note, "there is little systematic causal evidence that examines whether DT really enables individuals to be more creative and justly more confident." The aim of this paper is thus to investigate the DT team with an emphasis on team processes of divergent and convergent thinking using DT. The intention is to understand how team processes act on DT as a method to deliver innovation performance. Our research question is thus:

How do team processes during convergent and divergent thinking in design thinking influence innovation performance?

The study begins with a presentation of the theoretical foundation of the research, followed by discussion of the research methods, the data analysis, the findings, discussion, and conclusion.

Literature review

We will first give a brief introduction to design thinking (DT) and then present what we know about DT and team processes related to divergent and convergent thinking today. We will then discuss our perspective on team innovation performance.

Conceptual framework for team processes

To investigate the design thinking team, we employ the spin theory of Sjøvold, as this incorporates relationship transactions at the group level (see Sjøvold, 1995, 2006, 2007). Team members' actions are viewed not only as instrumentally related to the group's task but also as transactions in building (or de-building) relationships with the team. In this theory, group functions encompassing such relationship transactions are labeled: control, nurture, opposition, and dependence (Sjøvold, 1995). These behaviors are measurable through the SPGR instrument (Sjøvold, 2022), which is used in this study and will be further described in the methods section. In doing this, we adopt an approach to team behaviors rather than team characteristics (Busenitz & Lau, 1996; Gino, et al., 2010; Liang, et al., 1995).

The spin theory of groups is a further development of Bales' SYMLOG theory (Bales & Cohen, 1979) and integrates SYMLOG and Bion's (1961) theory of emotionality. The basic idea is that team members are all important actors in balancing various group functions in a way that is suited to deal with the specific problems that the group faces. Whether they actually succeed in doing this is a matter of how team functions are balanced and adapted to the task at hand. A successful team employs all functions when appropriate, thereby obtaining balanced relationships within the team. Notice that this is not a fixed state but one that fluctuates and is flexible according to both the dynamic context and in-group relationships.

In meeting different challenges, groups tend to exert different predominant behaviors (Sjøvold 2006, 2007). The predominant behavior of a group at any given point in time is an expression of what function the group activates (Parsons, 1951, 1953). The basic idea is that a group activates the function best suited to deal with the specific problem they face (in spin theory, functions are control, nurture, opposition, or dependence). When the control function is active, analytical, task-oriented, or even autocratic behavior dominates; when the nurture function is active, caring, empathic, or even spontaneous behavior dominates; when the opposition function is active, critical, assertive, or even self-sufficient behavior dominates; and when dependency is active, passive, conforming, an obedient behavior dominates.

A high-performing team is one capable of rapidly activating the group function best suited to meet any challenge at hand. To achieve such flexibility, all members of the group need to be capable of performing behaviors that support all four functions. We believe this framework to be well suited to the analysis of DT teams, as DT thinking is a method for complex problem solving, where teams need to iterate between convergent and divergent thinking processes. DT models expert designers, who combine convergent and divergent thinking along with deductive and inductive reasoning (Lee et al., 2020). At the team level, this attests to high flexibility in team members' behaviors.

Design thinking: a method for innovation performance

DT is hailed as a cornerstone of innovation (Brown, 2009) and, by some, as an effective tool for innovation (Tschimmel, 2012). DT may be thought of as a set of methods and specific elements that facilitate dialogue through a shared focus on users, turn-taking during conversations, and the use of visualization (Liedtka, 2017). Liedtka (2018) argues that, while significant scholarly work has appeared in design-focused academic journals, such as *Design Issues*, the attention accorded to DT as a problem-solving approach within top-tier academic management publications has been scant. Though anecdotal reports are plentiful, systematic assessment of DT and its utility as a problem-solving approach is limited (Cooper, et al., 2009; Johansson-Sköldberg, et al., 2013).

Teamwork is important for the concept, although research is scarce. Seidel and Fixson (2013) define this collaboration as "the application of design methods by multidisciplinary teams to a broad range of innovation challenges" (p. 19). Pezeshki (2014) has suggested that DT enables better conversations by shaping and directing the discussion, allowing new possibilities to emerge, and embedding the dialogic approach. This builds engagement and trust (Liedtka, 2018). Methods are diverse and used in various ways, but they often involve a quite structured process by which team members think individually (problem-solving) before they engage in a team debate. Ideas are often visualized, for instance, by using Post-It notes attached to a wall.

Miller (2015) lists five stages of DT: perspective-taking, defining a point of view, ideating in a team, prototyping, and testing. Based on a review of DT practices, Liedtka (2015) boils these down to three stages: data gathering about user needs, idea generation, and testing. This is in close correspondence to what Seidel and Fixson (2013, p. 19) term "needfinding, brainstorming, and prototyping." Needfinding involves user participation through some sort of data gathering. The aim is to understand who the end user is, what task they are designing a solution for, and how they currently accomplish it. Brainstorming is a group process that applies techniques that promote the search for new solutions that might not be possible through individual ideation. Prototyping is the process by which novel ideas are developed into a preliminary model, enabling evaluation of a given approach as well as the potential for further ideation (ibid.).

A typical DT process begins with the formation of heterogeneous teams that seek deep user understanding. They feed into a dialogue-based process in which insights, design criteria, and ideas are created. These ideas then move into testing, and the results determine the kind of feedback response necessary (prototyping). Underlying the entire process is an infrastructure of support and facilitation (Liedtka, 2018). The structure aids in and contributes to reducing feelings of insecurity and increasing comfort (Liedtka, 2017). After an initial phase, the result is user-tested. In other words, attention is given to the end user, his or her needs, and how the specific solution meets, or fails to meet, these needs. This should involve several iterations involving the end user in which problem and solution are jointly transformed. Such a process enhances usability (Heldal, et al.,2017; Norman, 1988).

Visualization is also important for the process. In traditional design environments, visual representations, such as a sketch or drawing, can enhance idea generation by structuring thinking and augmenting problem-solving abilities (Bresciani, 2019). Visual elements (both textual and graphic) immediately organize information in preparation

for communication or to provide clarity. In this context, designers continuously draw on their imagination and cognitive skills to develop new visualizations that are often based on previous representations during the conceptual design stage.

The potential linkages between the literature in organizational and team learning and the tools and processes advocated by DT's collaborative emphasis represent a fertile area for inquiry (Liedtka, 2017). This is what we will pursue next. Central to innovation and team processes in general are the concepts of exploration and exploitation (Heldal, et al., 2017), as well as the ability to be both creative and task-oriented. The DT concepts of convergent and divergent thinking are closely related to this, where creativity emerges from the overlap between convergent and divergent thinking (Lawson, 1980). This is similar to the contention of "explore" (divergent) vs. "exploit" (convergent), launched by March (1991) to describe organizations' ability to innovate. We will pursue next how DT methods relate to this.

Team innovation performance: DT and divergent thinking

Creativity is at the core of the DT process; in fact, one of the important values derived from DT is improvement in the creativity of solutions (Liedtka, 2017). DT has been described as the best way to be creative and innovative (Johansson-Sköldberg, et al., 2013). The popular version of DT is sometimes presented as a way to make managers think more creatively (Johansson-Sköldberg et al., 2013). The emergence and sharing of creative activities and cognitions in a social environment is also known as "co-creation" (Giaccardi, 2004, 2005). DT's emphasis on collaborative tools for sense-making and ideation would appear to be well-suited to facilitating such interaction. Exploration activities involve searching, discovering, and inventing (Heldal & Sjøvold, 2021), activities that may be related to divergent thinking in the ideation part of DT. Shi et al. (2017) suggested that divergent thinking, or producing multiple, related ideas for a set problem, is a foundation for creativity. Divergent thinking in DT is about producing multiple ideas and alternatives (Lee et al., 2020).

The structured process approach of DT has some challenges at the team level. Much of contemporary research advocates that exploration activities and divergent thinking in teams are dependent on team members supporting each other. Creativity and innovation research has advanced team cohesion as an important, if not the most important, team process variable (Hülsheger et al., 2009; Joo, et al., 2012). Team cohesion refers to the extent to which team members are committed to their team and how well the team is integrated as it pursues its goals (Kozlowski & Ilgen, 2006). The underlying rationale is that cohesion stimulates positive team member interactions (Hülsheger, et al., 2009) and is also important for DT processes (Lorusso, et al., 2021). Still, research on team processes acknowledges the perils of overly cohesive teams becoming too conformist. Researchers such as Langfred (2004) and J. Richard Hackman (2002) recognize the double-edged sword of cohesion, arguing that it may very well act on individuals as a controlling force. It motivates conformity (McGrath, et al., 2000), and highly cohesive groups will be less likely to produce innovative approaches to the task as individual attention is directed toward staying within the boundaries set by group norms and the group's past experience (Hackman & Wagemen, 2005). At the more serious and extreme end, cohesion becomes an ingredient in the phenomenon of groupthink (Janis, 1982) or

identity preservation (Turner, et al., 1992), in which group members become focused on the preservation of the group and their status within the group as opposed to efficient and effective engagement in their stated task (Pescosolido, 2003).

The DT literature is in agreement with the team research in recognizing the need for a supportive infrastructure to enable divergent thinking but pay lesser attention to the perils of overly conformity. Some of the reasons may stem from a lack of attention to team-level dynamics. Although DT has teamwork and team creativity as cornerstones (Lorusso et al., 2021), most studies seem to equate individual behaviors with team behaviors. In this paper, we adopt a different approach in that team processes' relation to team performance is profoundly more complex than just a summation of individual behaviors. Although team creativity is intuitively dependent on creative individuals, team processes (e.g., internal communication, team cohesion, and vision) have been shown to be more important (Hülsheger, et al., 2009). Tschimmel (2022) also questions the perception of personal creativity, arguing that a creative achievement is a matter of interaction between different actors. At the team level, all individuals thinking divergently at once may present different challenges than for the individual. March (1991) noted that imbalanced exploration may result in too much variance and greater coordination challenges. The team-level focus also raises a concern about all team members being supportive and conforming at the same time, risking over-conformity and even groupthink.

Team innovation performance: DT and convergent thinking

In DT, the divergent approach mentioned above is one that widens the scope or breadth of consideration of an issue, encompassing more factors, possibilities, and responses. In contrast, a convergent approach is one that narrows the scope or breadth of possibilities being considered, focusing on potential solutions (Lee, et al., 2020). Exploration may, in essence, be similar to divergent thinking, while exploitation is similar to convergent thinking. The exploitation perspective implies the notion of structure (Daft, 1992), which would entail structure-oriented behavior, such as a focus on authority and discipline. March et al. (1976) noted the importance of exploitation for innovation, as an imbalanced exploration may result in more variance than desired and much work without attaining results.

In many team-based projects, there is motivation to implement exploitation practices to minimize ambiguity and manage multiple task requirements (Gilson et al., 2005; Groysberg & Lee, 2009). Persistent team vigor, dedication, and absorption are crucial characteristics if teams are to stay focused on their efforts (Cheung, Gong, et al., 2016). A similar concept is that of task engagement. Researchers seem to agree that task engagement is important for performance (Rodrguez-Sánchez, et al., 2017), due to a common perspective on motivation around the task.

DT, as a method, is structured with prescribed steps, thus requiring team processes associated with exploitation behaviors, such as attention to structure and task orientation (Heldal & Sjøvold, 2021). A recent popular structure of DT involves "design sprints"—solving a customer problem in a very short time with short iterations (typically 4 or 5 days), using similar steps to those mentioned above but with an even higher attention to user involvement, prototyping, and speed. Although maintaining more open-ended and flexible processes related to divergent thinking is important, the momentum

and structure of a sprint are within a strictly defined limit. This draws attention to team processes related to discipline and authority, as the DT team needs, to an even greater extent, to coordinate their efforts.

Yet, DT literature is scarce on including these kinds of team processes beyond mentioning the attention to convergent thinking and that the method shapes the direction of discussions (Pezeshki, 2014). In fact, Lorusso et al. (2021, p. 23) mention that many DT teams "understand the value of DT in the initial stages of a project, but most end its application there, stopping short of utilizing its full potential by not applying the methodology throughout the latter phases of the design process." This suggests that the importance of exploitation behaviors such as coordination, discipline, and authority may have been underscored both in practical and scientific settings.

Team innovation performance: DT and psychological safety

Iteration is important to the DT team on several levels. Teams need to be internally focused as well as externally focused (user-oriented) and employ divergent as well as convergent thinking. The process is problem—as well as solution-focused, hypothesis-driven, and concerned with both the particular and the concrete. It relies on abduction and expects to cycle through multiple experiments that test a variety of solutions in an iterative way that actively works a variety of tensions between possibilities and constraints and is best suited to decision contexts in which uncertainty and ambiguity are high (Liedtka, 2018). DT research has not yet incorporated knowledge on team processes necessary for such transitions and iterations, besides the input value of a multidisciplinary composition (Liedtka, 2017). Csikszentmihalyi (1997), in his studies of creative individuals, noted that the ability to accommodate contrasting beliefs lies at the core of what differentiates these individuals. They were both playful and disciplined and both divergent and convergent in their thinking. These same tensions would later be used to describe the process of DT (Owen, 2007) and echo the iterative process described earlier. Tsoukas (2009) asserts that, given the difficulty of individuals creating their own disconfirming data, dialogue among people is key to accomplishing successful experimentation. "Thinking together," as Pyrko et al. (2016) describe it, requires mutual engagement around a shared problem in a conversation that is shaped but not controlled, in which the willingness to share tacit knowledge is critical. Vuillemot et al. (2021) find that visualizations and prototypes, important tools of DT, act as "boundary objects" in these conversations. Boundary objects are important cross-boundary collaboration facilitators (Heldal, 2008). Both practitioners and researchers emphasize the importance of such iterations, which in essence echo iterations between divergent (exploration) and convergent (exploitation) thinking.

Yet, team research advocates that transiting between these modes puts heavy demands on the team's processes. A main challenge may, for instance, arise from teams being too cohesive and supportive in the exploration phase, creating a culture of conformity. Such teams may have trouble with the discipline and structure required by convergent thinking (Sjøvold, 2014). As Csikszentmihalyi (1997) notes, this creates tension and ambiguity at the individual level. At the team level, it may be paradoxical in the sense of actions that cancel each other out and/or are mutually incompatible, for instance, with some members engaging in exploration behaviors and others in exploitation behaviors (Heldal,

et al., 2017). In other words, it may crash the team. As such, iterations may be the basis for disagreements and even conflicts (Sjøvold, 2014). Seidel and Fixson (2013) find that the better-performing DT teams experience a higher level of debate, suggesting that behaviors related to task conflict enhance a kind of reflexivity needed to balance exploration and exploitation. Task conflict is indeed positively related to group outcomes such as cohesion through the exercise of voice in team decision-making. The exercise of voice, or voicing up, is in turn an important factor in psychologically safe groups and has been seen to enhance both creativity and efficiency in DT groups (Edmondson, et al., 2001; Stålsett, 2017) and contribute to explorative as well as exploitative learning (Kostopoulos & Bozionelos, 2011). Psychological safety is a team construct that is about the ability to take interpersonal risks in a particular context, such as a workplace (e.g., Edmondson 1999), through a willingness to contribute ideas and actions to a joint task. For example, psychological safety helps explain why employees share knowledge and information, take initiative in new product development, and speak up with suggestions for organizational improvements (Edmondson & Lei, 2014). Psychological safety may influence team learning activities, because team members tend to choose their actions on the basis of the level of risk they attach to them (Edmondson, 2003; Yagil & Luria, 2010). Psychological safety as a team construct may thus be an important enabler of a performing DT team, yet we know little about its relationship with the DT methods or structure.

Method

To investigate how team processes influence DT as a method to deliver innovation performance, we employed a mixed-methods approach, both qualitative and quantitative. We employed this approach to draw on the potential strengths of both qualitative and quantitative methods (Tjora, 2018) and to answer calls for more objective studies on team innovation performance. Objective empirical studies exist but involve mostly the use of cross-sectional designs with subjective performance measures (Sarin & McDermott, 2003). In our study, we employ a longitudinal design with objective measures of team innovation performance, answering the call of Kostopoulos and Bozionelos (2011) and Marks et al. (2001), who argue that longitudinal designs are still lacking for much of teamwork research in general. We combine this with the in-depth knowledge provided by qualitative data often needed to understand quantitative measures of team processes (Heldal, et al., 2020). We will first describe the teams and the setup.

The teams

The investigation was performed on a sample of master's-level students with different engineering backgrounds. These students were randomly assigned to teams, each consisting of groups of 3–5 students. In the group composition, we deliberately sought different academic backgrounds and little or no knowledge of the other team members. Team members did not know each other beforehand and had diverse engineering backgrounds. They were otherwise randomly distributed with regard to gender and age. We performed a check on the students' overall grading score cards, both before the test and after, with no significant differences appearing among the groups. We thus have reason to believe that students of varying abilities were evenly dispersed within the teams, so that we may attribute differences in performance to team

processes. All teams were explicitly performance-oriented, aiming for top grades. Participants were asked for consent to use the results in our research and informed of which data were gathered and how they were used. They were further informed that participation was voluntary and that they could withdraw from the study without any consequences and have the collected data deleted at any point. No names were given in the reflection notes (Table 1).

The setup

The teams' task was to: (1) come up with an innovative business idea; and (2) develop a business plan for this idea. The ideas were developed according to the framework of Osterwalder and Pigneur (2010). This is labeled a "business model canvas" and consists of a visualization tool with nine "building blocks" that are to be performed iteratively. The teams followed the core framework of DT as follows:

- Needfinding: Teams were asked to think of an idea individually that would resolve an everyday problem for a specific user and come up with as many ideas as possible.
- In the idea-generating phases, ideas were noted individually on sticky notes that were attached to the Osterwalder canvas on the wall. Discussion and reflection together could then follow, employing a brainstorming process.
- The whole process had several idea-generating phases (following the building blocks in Osterwalder mentioned above).
- After each idea-generating phase, participants were encouraged to single out one idea to pursue (for instance, choosing one customer group).
- Changes in one building block lead to changes in other building blocks, thus requiring us to work iteratively and not linearly. Teams could iterate as many times as necessary (as judged by the teams themselves). All teams were encouraged to involve end users as much as possible (and other relevant actors that could offer information) through prototyping and/or other involvements (observations, interviews). All user interactions were logged, and all teams had extensive external activities.
- The Osterwalder Canvas (explained above) was used as a visualization tool.
- All teams worked with the canvas in an A3 format, either hanging on the wall or laid out on a table. All teams employed story-boarding as part of the process (sketching up the process through either a drama, video, or cartoon). The user story was "performed" in an 8-min pitch, in which the business idea was to be presented to the business developer.

Table 1 Overview of respondents

	Number of persons	Number of groups	Number of ratings
A-groups	79	19	350
B-groups	96	23	415
C-groups	39	9	171
Total	211	51	936

All teams were encouraged to work iteratively with potential customers and clients, as is the core idea of DT (Head & Alford, 2013). The business ideas were assessed by one or two professional business developers according to the following criteria, in line with the framework of Sørheim and Botelho (2016):

Is the business idea sufficiently new and innovative?
Is there a market/customer need for the idea?
Do we possess the right resources on our team?
Is the financial plan thoroughly worked out?
Ideas were, as a whole, subsequently rated as follows:
A: The business idea and corresponding business plan are good enough to be further continued/developed.
B: The business idea and corresponding plan have some merit, but need some work or changes.
C: Do not invest in this plan.

All groups thus identified as either an A-group (top-performing), a B-group (medium-performing) or a C-group (low-performing). Although groups could show similarities, the separation was used as an analytical tool to investigate differences between the groups. Quantitative findings are based on the SPGR instrument, while qualitative assessments are based on observations, notes from the coaching sessions, and analyses of the reflection notes.

Quantitative measurements

The Systematizing Person-Group Relations tool (SPGR), an operationalization of the spin theory mentioned in the theory section, was used for data gathering and investigation (Hare, 2003; Sjøvold, 2007). The teams were all measured with this tool (as described below) 1 week after the start of the study and 1 week before the presentation of the plan. According to Seidel and Fixson (2013), some teams may do well in the conception phase but fail to maintain performance in a later phase. We wanted, therefore, to employ measurements in more phases. The survey was distributed electronically. The time span of the process was 8 weeks. After the first test, teams were informed of the results and asked to reflect on possible measures. In the second session, the groups were encouraged to reflect on the effects of their chosen actions and the resulting dynamics. Teams were also required to hand in reflection notes at the end of the process.

The SPGR tool is based on the semantic differential scaling technique established by Osgood et al. (1957). Earlier studies (Koenigs, 2000; Sjøvold, 2007) have described the validity and reliability of the SPGR tool, and the instrument has been used in different settings (Andre & Sjøvold, 2017; Heldal, et al., 2004; Schultz Joseph, 2017). The subsequent detailed appearance of the SPGR tool is presented similarly to the methodological descriptions in an earlier study (Snider & Osgood, 1969). The SPGR scale consists of 24 items describing team interactions/team behaviors based on different combinations of the four group functions Control, Nurture, Opposition and Dependence. Each item is rated on a scale of the interaction, described as occurring never or seldom (1), sometimes (2), or often (3), and each group member rates each person within the group

Table 2 Overview of SPGR functions and theoretical connections

SPGR function name	Team behaviors
C1—task-orientation	Analytic, structured, logical, task-oriented, time-oriented, neutral, punctual
D1—loyalty	Willingly working, following norms, trustworthy, precise
S1—engagement	Inspiring, motivated, lively, involving other opinions, solution-oriented, positive
S2—empathy	Open, involving others, smiling/laughing, actively listening, encouraging others, interested in others
D2—accept	Accepting group norms, listening, recognizing others, giving into others, grateful, asks for help
N1—nurture	Openly attentive to other's needs, supporting others, offering help, offering trust, offering a snack
N2—creativity	Intuitive, dramatic, spontaneous, looking for absurdity, experimenting, breaking norms
O1—critique	Openly disagreeing, doubtful, attentive to aberrations, challenging norms, questioning authority
W1—resignation	Non-talkative, not participating, non-responsive, passive, low confidence
W2—self-pity	Sad, complaining, expresses sorrow and disbelief, self-pitying
O2—self-promotion	Demanding attention, rough, rigid, aggressive, tough, individualistic, blunt, brusque, stepping on others
C2—control	Steering, controlling, authoritarian, rule managing, agenda setting, time-limit-oriented

accordingly. This results in a profile of each group member's interactions within the group. The 24 items are, for analytical purposes, synthesized into 12 functions. These are described in Table 2, with links to previously presented theories. Differences between groups´ functions were analyzed using one-way ANOVA analysis followed by a post hoc Tukey test. The Cronbach alphas for the questionnaire in this study vary from 0.78 to 0.92, depending on the subject in question.

Qualitative assessment

All groups were observed by the author twice, following the team tests. Groups were asked to explain team results and reflect on their own performances. During these observations, notes were taken in situ, observing actions rather than interpretations (Tjora, 2006). The aim here was to understand the dynamics of the groups and how they reflected on what was important to them. Important factors that were attended to using the framework of Sjøvold (1995) were communication in terms of: who speaks and when; do they address each other; are they forward-leaning; are they attentive to tasks at hand; are they easy-going or serious? In other words, behaviors were analyzed according to the four group functions mentioned above. Groups were also asked: (1) How do you judge your own performance? (2) How do you attend to the proposed plan? (3) If anything, what would you improve? We wanted to investigate levels of inclination towards task orientation and structure (convergent thinking) vs. well-being and feelings of content and creativity (divergent thinking) and how they related to the DT methods. In the reflection notes, we sought reflections related to the factors mentioned above.

All notes were material for textual analysis. The texts were analyzed according to Tjora (2017) using four steps. First, we developed what Tjora (2017) calls "empirically close codes," small snippets of text representing elements in the texts. We then extracted these five themes: (1) focus of loci; (2) attention to learning; (3) group climate; (4) measures taken; and (5) own perception of performance. From these, we developed what Tjora

(2017) calls a concept, a metaphor close to the final conclusion. The reason behind this is to reach a more generic and abstract understanding of the data (Tjora, 2017, p. 72). We developed a concept for each of the groups:

> A-groups are the impatient, systematic, and challenging groups;
> B-groups are the wanderers; and.
> C-groups are the happy-go-lucky groups.

The overarching concept was a disciplined DT team. Concepts are possibly understood as legitimate results (Glaser, 1992) as well as a basis for theory development. Here we also use them as illustrating metaphors for what we will later present in the findings section. The fourth and last step, termed "theory development," involved the understanding of the concepts and the themes in light of previous research.

Generalizability

We acknowledge the limitations of using Norwegian student groups, as both context and perceptions of tasks may differ from real-life situations. Students may have different motivations for completing team tasks than seen in other teams. There may also be cultural differences that are not addressed specifically here, although the team literature in general rarely addresses this issue.

Still, we believe it has some merit to standardize tasks and context for a large number of groups. Although on a much smaller scale, the results from this study have shown promising and valuable inputs for start-up projects working with similar problems. The value of iterating flexibly between divergent and convergent thinking in complex problem solving has long been confirmed in team research, and depending on context, this study attests to important lessons from DT as a method. As with DT, however, it is not decisive if the study will have value for problems that are not of a creative or complex nature.

Results

We will first present the findings from the qualitative assessments of the groups and then the findings from the quantitative analysis.

Qualitative description of the groups

All groups were instructed similarly in how they should work with DT methods. We will here present the groups according to their final results on the project: A C-group (poor result), a B-group (mediocre result), or an A-group (top result).

C-groups: the happy-go lucky

Albeit aiming for performance, most of these groups started their projects with an attention to team members' well-being and enjoyment. This inclination could take different forms. When asked, some indicated that this was intentional, while others drifted into it. One of the groups stated that their aim was to build a safe and cohesive group within which it was safe to be creative. Within the initial task of coming up with ideas through need-finding, they managed to build upon each other's ideas through brainstorming.

However, all ideas were supported, with the underlying intention of keeping a sense of well-being in the group. This created a problem in that they struggled with disregarding poorer ideas and continuing with fewer, or even a single idea, to develop further. This problem of selection characterizes most of these groups. This led to significant losses in the initially high energy levels within the groups because they became resigned and fell into a kind of stalemate. They managed to develop their projects and deliver them, but as time went on, they became more and more characterized by passivity. Despite the apparent energy loss, the abovementioned group openly expressed their happiness with the group and regarded themselves as top performers. Not all of these groups were similarly enthusiastic, ranging from not wanting to express discontent (everything is OK) to openly bragging (we are the best).

The attention to the group's wellbeing seemed to cause a mild attention to the process and task at hand. As explained above, although brainstorming sessions were performed, there was a hesitation towards discussing the ideas. Not all ideas were written down and put on the post-it notes, and not all of these in turn were thoroughly processed. Rather than maintaining a focus on client problem-solving and following the DT process, norms rather quickly developed into an attention to building a cohesive team. The intention was to build a basis for knowing each other, upon which they could later collaborate. One group expressed this as follows:

> *"Early in the semester, during the "forming phase," the group emphasized getting to know each other and being liked. In the beginning, there was not as much focus on working hard on the tasks as on learning about each other. Furthermore, in the development of the group, we may have been a little too caring, and it has not been the norm in the group to express dissatisfaction or to have strong opinions about how tasks should be solved. If we had had a more task-oriented leadership role, the efficiency of the work would probably have increased." (Reflection note C-group 1)*

The concept of "flat structure" was important in many of these groups, meaning that they did not want an authoritarian leader. This was thought to be of essence for the groups' wellbeing, and the ability for all of them to participate in decision-making and in co-creating the idea. As time went on, however, as C-group 1 expressed in the quote above, this developed into low efficiency. One of the other groups stated:

> *"The group started working early on well-being among the members and focused on creating trust in each other. This was extra important as the group wanted a flat structure, and everyone had to be able to take the leadership role without being met with unnecessary skepticism." (Reflection note C-group 5)*

A large part of what these groups thought to be a success was their attention to the social aspects of the group. That meant that one of the things these groups actively paid attention to was the nurturing of the group members (literally), often identifying this as a dedicated responsibility. This was not only at the start but continued as the project developed. Even if some may have had the intention of being more task-oriented, they seemed to enjoy this mode of working and also credit their performance to this emphasis. One of the groups reflected as follows on a specifically assigned role: taking care of social responsibilities:

> *"They have the responsibility of bringing cake to the meeting at the end of each week, which has been a success. This creates a climax at the end of each week, which the group members look forward to and work towards. In our group, it has been experienced that the group members build each other up due to shared responsibility. Complements are given for the work they have done, and this also spreads to professional work with the task at other times of the week." (Reflection note C-group 2)*

This way of working was reflected in their weak or effortless attention to the DT process. As mentioned, they did struggle early on with the disregard of ideas. This in turn reflected on their ability to enable iterations with their clients. In essence, there were few iterations, and the groups seemed content with the initial information they had gathered. This was reflected in their ideas, which were developed only to a limited extent. Often, the initial idea from the first week was established and confirmed but not improved.

A-groups: the impatient, systematic and challenging groups

The most salient characteristic of the top performers was their dynamic approach to teamwork, combined with a disciplined structure towards the process. Paradoxically, there were large differences between the groups in how they worked together. One group had to split up because one of the members was ill and had to work from home the whole time. Another group, consisting of three members, decided after 2 weeks that they could not work together. They split up, with two of the members working together, while the third member worked alone, coming together only to decide on deliverables and future tasks. The other groups would co-work along the whole spectrum, from splitting up to being together most of the time. Characteristically, these groups worked in a systematic and disciplined manner, with a focus on task orientation but also paying some attention to team relationships. For instance, many of these groups fixed team roles early (only two of the groups did not) and employed more formal roles than the other groups.

With regard to DT, these groups were the ones most attentive to performing the process "by the book." This entailed more structure. For instance, the brainstorming process more often than not concluded with the selection of one idea. Ideas were visualized, and leaders were attentive to everyone using the sticky notes and adhering them to the wall. And not the least important was that each idea, or post-it note, was given the proper attention and discussion, especially in the selection phase. Iterations were performed methodically. However, with regard to team processes, it looked very different from group to group, as explained above. When asked, these groups would typically answer that the chosen path of working together was how they could best manage the DT process, solving the problem for the client. They were also always very attentive to the iterations of these processes. It was, for instance, common that one person knew the client better than the other team members and thus could work more closely with them. If so, however, these teams would spend dedicated time afterwards reconvening the whole group to share new information. Other A-groups would take turns collecting information. Regardless of how they did it, they discussed the information, reflected upon it, and seemed to learn together with the client. This was usually also reflected in their ideas; the initial prototype from week 1 was extensively altered and improved.

Most of the A-groups would employ a team leader (as did some of the other groups), but also a secretary and sometimes even a devil's advocate. A clear structure appeared in how they rotated through these roles. In contrast to the C-groups, these groups were quick to decide on the business idea to be developed. This necessarily involved firmness and the discarding of some ideas. They worked on challenging each other, both with tasks (e.g., deliverables) and team relations (e.g., performing the role), from the very start. Approximately half of the groups were, by coincidence, subjected to adversity they had to overcome. Common among these was that they dialogued and communicated through adversity, employing honest feedback. The other half did not experience adversity but still, in much the same manner, communicated and dialogued with honest feedback. Observing and conversing with these groups would take the form of an almost eager impatience in the groups. They continuously maintained a clear perception of what they should work on to get better. The A-groups were never completely satisfied with their work and group and always showed an eagerness to improve. And this improvement and discipline were, in essence, connected to using the DT process and the best-adapted team dynamics. The latter could, as described above, differ among the groups. The groups found their way forward in supporting the DT process by discussing and reflecting on the best way to move ahead.

> *"The group gathered to discuss how the rotation of leadership roles should be carried out as well as what requirements should be set for the leadership roles. Through this process, one person was very clear on what he expected from the others. Great demands were made on what had to be met by them, and if those expectations were not met, this person expressed that he had to intervene to take over the leadership role." (Reflection note A-group 7)*

This kind of toughness and directness characterized the dynamics in most of these groups, without turning into conflicts. They were accustomed to this way of communicating and agreed to challenge each other.

> *"At present, we as a group have raised more sensitive and uncomfortable topics to challenge each other." (Reflection note A-group 13)*

As noted above, also disagreements were to some extent worked through systematically, often with a basis in the business canvas and the visualized notes.

Interestingly, a minority of the high-performing A-groups did similar things as the lower-performing C-groups, such as bringing a cake and employing a flat structure. A possible interpretation is that the A-groups used these measures more task-orientedly than the C-groups (I will return to this in the discussion section).

B-groups: the wanderers

Compared to the C-groups, the B-groups did not openly express an interest in well-being and being top performers. They were more similar to the A-groups' impatience and eagerness to develop and were, as such, pro-active and forward-leaning. In brainstorming, they managed to both come up with multiple ideas and choose one to go forward with. However, they seemed less firm and structured than the A-groups in doing this, and some groups experienced re-considering ideas that had been disregarded. They

could seem more task-oriented than the C-groups, more attentive to the work that had to be done, but at the same time, they also experienced misunderstandings with their intentions. As a whole, these groups displayed many of the same characteristics as the A-groups but did not seem to employ them in a systematic and structured fashion. For instance, one of the things that distinguished the A-groups was their ability to challenge each other and each other's views with an attention to psychological safety that the B-groups would try to emulate. However, they did not engage in this process wholeheartedly or systematically. Many of these groups would, for instance, use a "devil's advocate" to challenge the group's ideas. In contrast to the A-groups, though, the B-groups would try this as an idea (maybe doing it once or twice) and then disregard it. Some of these groups were satisfied with their performances, while others were more indifferent.

With regard to DT, most of these groups were attentive to the process and the task at hand. However, their minds seemed to drift more often as they could not manage to maintain the discipline necessary to stay on task. This could be seen, for instance, in how they dealt with iterations. Many of these groups followed a more linear path in their product development, which resulted in few improvements and developments from the original idea. The A-groups, in contrast, would often end up with solutions very different from what they started out with. Where the C-groups were content and not seeking any improvements, the B-groups, on the other hand, could acknowledge that they needed improvements and suggest actions to be taken. However, as opposed to the A-groups, they would often not stick to the program.

> *"The group members believe that the group discussions could have been more effective if they had a person who led the discussions and resolved the group's derailments. The group members also lacked a person who would have followed up on the execution of the tasks and would have set clear expectations and goals for each group member." (Reflection note B-group 20)*

This tendency to drift was attributed by most to not only the lack of a clear structure and having a leader or a person that could finalize decisions, but was also reflected by some as a fear of performing this role in too authoritarian a manner:

> *"Even though the group decided to have a leader, the group in practice has had a flat structure. We believe that this was because the group members were not well enough acquainted with each other at the beginning of the collaboration, and because they were careful to take on the leadership role. The group did not have a clear picture of, or a standard for, how a group leader should be or what functions he or she should perform. The group members who had the leadership role were therefore afraid of appearing too totalitarian and demanding. Often, there was uncertainty about who was actually the leader at the moment. This led to the leadership role becoming quite weak." (Reflection note B-group 4)*

The lack of structure was common for these groups. Another important characteristic was that, only in hindsight, could they reflect on improvements. The A-groups, in contrast, had on-going reflections; while the C-groups more often than not did not openly acknowledge any improvement factors. The above-mentioned lack of structure and discipline in performing the leadership role, reverberated in the weak performance of other

roles, for instance, the Devil´s Advocate. As reflected above, some attributed this to being unsure of each other, while others attributed this to a lack of task orientation:

> *"In the start, it would have been advantageous to structure the working days better and specify smaller sub-goals... ...We assume that, with better planning and structure, the time pressure towards the submission deadlines would be easier. We see in retrospect that it would have been positive if we had had a more task-oriented focus earlier in the project and used the role of the devil's advocate more actively." (Reflection note B-group 11)*

Quantitative findings

In this section, we will present the results from the SPGR questionnaire. These measurements were performed in the first week of the project, when the main task was to conceive of a possible business idea, and in the second to last week of the project, when the main task was to finalize the project and rehearse a pitch (Table 3).

Table 3 Measures of team behaviors

Team behaviors			A-groups (M)	B-groups (M)	C-groups (M)	Significant differences
Accept	D2_1	Round 1	3.30	3.36	3.65	C1 > B1 (*); C1 > A1(*); C2/B2 > A2 (**); C1 > C2(*)
	D2_2	Round 2	3.34	3.42	3.49	
Nurture	N1_1	Round 1	3.23	3.08	3.38	B1 < C1 (*); A1 < C1 (*)
	N1_2	Round 2	3.23	3.19	3.31	
Creativity	N2_1	Round 1	0.43	0.40	0.25	A1/B1 > C1 (!); B2 > B1 (**); C2 > C1 (*)
	N2_2	Round 2	0.51	0.71	0.45	
Critique	O1_1	Round 1	0.70	0.56	0.36	A1 > B1 (*); A1 > C1 (*); B1 > C1 (**); B2/A2 > C2(*); A1 < A2 (**); B1 < B2 (**); C1 < C2 (**)
	O1_2	Round 2	0.84	1.04	0.62	
Selfpromotion	O2_1	Round 1	1.21	1.10	1.00	A1/B1 > C1 (*); A2 > C2 (*); B2 > C2 (*); B2 > B1 (**)
	O2_2	Round 2	1.21	1.45	0.96	
Control	C1_1	Round 1	1.61	1.45	1.26	A1 > B1 (!); A1 > C1 (*); B1 > C1 (*); A2/B2 > C2 (*); A2 > C2 (**); A1 < A2 (**); B1 < B2 (**); C1 < C2 (**)
	C1_2	Round 2	1.84	1.75	1.47	
Task orientation	C2_1	Round 1	2.80	2.77	2.58	A1/B1 > C1 (*); A1 > C1 (*)
	C2_2	Round 2	2.81	2.86	2.62	
Loyalty	D1_1	Round 1	3.22	3.11	3.34	C1 > C2 (**)
	D1_2	Round 2	3.15	3.11	3.15	

** Significance at the 0.01 level; * Significance at the 0.05 level; ! Significance at the 0.1 level

A1 = A round 1 (n (ratings) = 350); A2 = A round 2 (n = 343); B1 = B round 1 (n = 415); B2 = B round 2 (n = 415); C1 = C round 1 (n = 151); C2 = C round 2 (n = 151)

First week (1 of 8)

First, there is only a weak statistical difference between the groups with regard to the N2 vector, creativity. Notice the relatively low score here in comparison to other team behaviors. However, the A-groups are, by this measure, the most creative, although observations suggested similar usages of the initial phases of brainstorming (coming up with ideas). Findings further suggest that C groups work significantly more than A and B groups toward group conformity in this phase. This shows in their significantly higher scores in the D2 vector, which denotes interactions oriented towards acceptance of the group and conformity. A similar but opposite tendency is shown in the O2 vector, which denotes interactions that promote the individual self. Although the significant difference is not as strong here, the A and B groups are significantly higher on this vector. This attests to the higher levels of confrontation from the start among the top performers. A-groups differ significantly from the other groups in exhibiting higher levels of C1 (control) and task orientation (C2). This suggests that the A-groups worked more methodically and were more disciplined (C1), with attention to the achievement of a result (C2) from the start, while the C-groups emphasized getting to know each other and building a positive climate. These findings correspond to observations of the brainstorming process. The convergence of many ideas into one requires discipline and confrontation when needed, as exemplified by the top performers.

Last week (7 of 8)

In this phase, there are no statistical differences in D1 (task conformity). All groups work similarly with regard to task orientation. However, C-groups continue to show significantly more conformity behaviors (D2) than the A-groups, with the difference that B-groups here show more similarity with the C-groups. B and C groups are both lower than the A groups at the 0.1 level. A and B groups continue to be significantly higher in self-promoting behaviors (O2) than C groups and in critical and opposing behaviors (O1). Taken together with the conformity behaviors, this suggests that A-groups demand more of each other and that "voicing up" behaviors are not a problem with regard to unification around a common task. This may be the result of the discipline exerted by the A-groups. A-groups differ from the C and B groups, with a significantly higher level of authority and discipline-oriented behaviors (C1). Even though the numbers appear to show large differences in task orientation (C2), the differences are not significant. Taken together with the other findings, this suggests that A-groups show unity in performing through a coordinated (disciplined) approach. Individual contributions are still promoted, and they demand more from each other than the other groups. This corroborates the qualitative findings in that emotions were quite high within all groups as they approached the deadline. In contrast to the B and C groups, however, the rough behaviors of the A-groups translated into constructive discussions while, for others, these behaviors often led them into quarrels or disputes, as happened with one of the C-groups. But more often than not, the C-groups in particular refrain from these kinds of behaviors, either not acknowledging them or not perceiving them.

Discussion

How do team processes during convergent and divergent thinking in design thinking influence innovation performance? Design thinking (DT) is, by its nature, about pushing the team to iterate. Still, the empirical results suggest that this is not necessarily so easy with regard to team processes. The more supportive-oriented groups struggled a bit with iterations between convergent and divergent thinking, although they eventually made transitions. The more task-oriented groups seemed more adapted to iterations through a disciplined and honest dialogue around the use of DT tools and development. Previous research has paid little attention to the associated team processes, other than suggesting creating a supportive and positive climate. We will further discuss these findings, paying attention to the following two arguments: Firstly, DT methods, with their attention to rapid iterations, positively influence important dynamics in team processes related to innovative performance. The use of visualization techniques enables a supportive and honest team climate and cohesion, which are associated with innovative performance. Secondly, this influence is further enhanced by a disciplined attention to the iterations between convergent and divergent thinking, along with an attention to psychological safety. Team processes directed towards conformity and supportive behaviors, in addition to DT, may foster team conformity and inhibit innovation performance.

We will first discuss how the teams worked with divergent thinking. A general conception of DT teams is that they are driven by creative processes, or at least employ methods that elicit the creativity necessary for the purpose of innovation (Stålsett, 2017). Our quantitative results suggest that DT teams actually spend little time being creative in the form of divergent thinking. Creative behaviors were significantly lower than other team behaviors. We will argue that this may be a result of how they worked with creativity. Qualitative data suggests that, for instance, brainstorming was used by all groups in the form of coming up with ideas and playing with them. Generating ideas was not problematic for the groups, as they engaged in thinking divergently, in DT terms. Previous research attests to the importance of a supportive climate (Liedtka, 2017) for the ability to accommodate contrasting beliefs (Csikszentmihalyi, 1997), thus building on each other's ideas in this phase of the process. This ability to accommodate contrasting beliefs is enhanced in DT, because all ideas are visualized, and there were no signs in the groups of this being problematic. In fact, it is likely that this technique of urging all members to express ideas and putting them forward in their groups contributed to building a supportive atmosphere based on honesty. Following the DT process, this was the very first thing the groups did together, and they all scored themselves highly on supportive behaviors in the first week. It is difficult to say if the groups became more creative through the visualization technique. However, it is possible that the visualization process, urging all team members to partake, helped to build team cohesion around honestly supporting each other. This is in line with previous research. Pezeshki (2014) has suggested that DT enables better conversations through shaping and directing discussion, allowing new possibilities to emerge, and embedding the dialogic approach. This builds engagement and trust (Liedtka, 2018). The visualization process may, as such, have functioned as an enabler of psychological safety within the groups, giving them the ability to speak up and promote their own meaning and perspectives (Edmondson & Lei, 2014).

It was with the important transition from thinking divergently to thinking convergently—and propagating this into an iterative process—that the groups' team processes took different paths. What all groups struggled with was turning several ideas into one, or, in other words, going from divergent thinking to convergent thinking (Lee, et al., 2020). As Csikszentmihalyi (1997) notes, creative individuals are both playful and disciplined, both divergent and convergent. This echoes a tension that forms the iterative process of DT (Makary et al., 2006). All groups visualized notes attached to the business canvas, making all ideas visible for the whole team. Visual thinking techniques potentially support both divergent and convergent collaborative tasks (Eppler & Kernbach 2016). That is, DT in teams relies on visual representations for idea generation as well as collaborative analysis and decision-making. And innovative teams, while relying steadily on explorative thinking divergently, also need attention to structure and task orientation (exploitation) thinking convergently (Heldal & Sjøvold, 2021). What we find here is that the visual representation indeed enabled idea generation (divergent thinking), which was easy for the teams, but that the shift to analysis and decision-making required discipline and task orientation (convergent thinking), which was more difficult. The top-performers (A-groups) scored significantly higher on these behaviors than the rest, suggesting a value in following the DT method structurally and disciplinedly. As such, we may argue that discipline and authoritarian team behaviors enabled convergent thinking.

A possible interpretation of the quite low attention to creative behaviors in combination with high cohesive behaviors was the need to follow a quite structured process through a sprint (short time), and this resulted in a form of task cohesion. In fact, all groups displayed higher levels of task orientation and control (convergent thinking) in comparison to creativity (divergent thinking), suggesting a higher attention to problem-solving behaviors than playful and divergent behaviors. We will explore further how a disciplined attention to the structured process of DT may have worked to achieve team cohesion or the team feeling necessary for this kind of decision-making. Anderson et al. (2004) argued that strong cooperative norms through discussing and building on each other's ideas contribute to creative success instead of the pursuit of individual goals. Dialogue is, in this fashion, shaped but not controlled (Pyrko, et al., 2016). Hülsheger et al. (2009) advocated the importance of cooperative behaviors and a supportive atmosphere for creative and innovative activities. Results indicate that these behaviors were clearly accentuated while still indicating, among the top performers, an inclination toward task orientation and discipline. We argue that the A-groups' systematic and disciplined approach to the task built a kind of structured cohesion around the task. This is also found by previous research to be the most problematic part of DT. In fact, Lorusso et al. (2021, p. 23) mention that many DT teams "understand the value of DT in the initial stages of a project, but most end its application there, stopping short of utilizing its full potential by not applying the methodology throughout the latter phases of the design process." Rodriguez-Sánchez et al. (2017) clearly support this thesis with regard to team performance in general and argue that the collective engagement around a task enhances intrinsic motivation. The poorer-performing C-groups, on the other hand, built cohesion around the notion of well-being and fun and, as shown in the data, paid less attention to following the DT program. This was not because they disagreed, but because their attention drifted more and more toward team conformity. The B-groups showed a different

kind of dynamic, starting out with motivation for something in between and getting lost. In our study, the best teams also showed significantly higher attention to the need for discipline and structure in resolving the task, getting more structured and disciplined as the project progressed. This supports the thesis that DT is better enabled through a disciplined and structured approach, which, in turn, enables team cohesion. Starting with attention to a supportive atmosphere may, on the other hand, lead to motivation elsewhere and build team norms of conformity. Team norms may establish themselves quickly, especially with reinforcing behaviors such as those in the C-groups (Heldal & Dehlin, 2021).

The use of visual thinking is important in DT and aids in structuring ideas and representations (Lee, et al., 2020). The word "structure" is important here, as it further attests to the importance of convergent thinking. The best achievers in our study managed the transition from divergent to convergent thinking, choosing ideas to discard without ruining the collaborative climate. They showed higher levels of team behaviors associated with convergent thinking. This presupposes discipline and authority in the team processes, as argued above, but also, as we will argue next, psychological safety at the team level. The convergent thinking part of discarding ideas seems to require elements of psychological safety, the ability to voice concerns, and being critical (Edmondson, et al., 2001). This argument is confirmed by the observations of conflicting behavior in the groups. The best-performing groups employed more of these behaviors than the others. Interestingly, this may have also contributed to these groups' divergent thinking abilities. In fact, collaborating and being direct without fear of condemnation is an important factor in being creative together (Pescosolido, 2003). This attribute is essential for the design team to be creative because it mitigates group conformity (Stålsett, 2017). It is possible that the visualization of individual ideas, as previously argued, not only enabled a supportive climate but at the same time mitigated the effect of group conformity. This, in turn, hinged upon the teams' ability or motivation to converge their thinking around ideas in a structured way. A disciplined and structured approach to each idea (as the A-groups employed) may have opened a safer space where disagreeing and arguing were important. The latter is an important tenet of psychological safety: that opinions are voiced and disagreements are not shunned but praised (Furuset, 2021). C-groups, on the other hand, emphasized the supportive atmosphere of being creative together and avoiding conflicts, thus developing non-constructive levels of group conformity.

The visualized ideas on the post-it notes may, for the A-groups, have served as "boundary objects" (Vuillemot, et al., 2021), because they were disciplined in employing them in discussions. Neither the B-groups nor the C-groups did this. The facilitation of cross-boundary collaboration using boundary objects is based on teams' ability to communicate reflexively (Heldal, 2010). Seidel and Fixson (2013) suggested that high levels of debate were associated with high levels of reflexivity, which in turn enabled high performance. This may be a sign of the importance of being reflexive in the use of DT. The top performers maintained a continuous reflective dialogue on the best way to move ahead, and most importantly, they did this in an honest and direct way. Arguably, they experienced levels of task conflict (Dreu & Weingart, 2003), but employed this in a constructive way by being task-oriented and disciplined. It is also possible that the top performers' more conscious use of visualization of ideas on the post-it notes contributed to

constructing the team mental model, as this contributes to the sharing of tacit knowl-edge (Pyrko, et al., 2016). As such, they worked continuously to develop shared men-tal models, both at the team and task levels, which is important for team performance in complex team tasks (Heldal, et al., 2020). Knowledge visualization systems facilitate team communication and reasoning processes. Such systems are used to shape knowl-edge—to abstract, diverge, converge, structure, elaborate, and evaluate—as part of the process of building a team mental model (Briggs, et al., 2001). This argument of team reflexivity should also be seen in conjunction with the top performers' ability to work structurally and in a disciplined manner.

We conclude the discussion, based on the above, with the following argument: the findings suggest that the DT process as a method contributes to team cohesion and iter-ation between convergent and divergent thinking. Teams' ability to exploit the method to achieve innovative performance is, however, dependent on team processes related to a structured and disciplined attention to the method in relation to psychological safety. The study supports previous research in that convergent thinking is more problematic than divergent thinking at the team level. This transition is important for the ability to innovate, but previous research has not been clear on why this transition is difficult. We find that teams that devote conscious and dedicated attention to establishing a support-ive climate may establish norms of team conformity that hinder both the transition and the iteration. On the other hand, we find that teams that attend to psychological safety through an honest and reflexive dialogue, combined with a structured attention to the DT method, iterate easier between convergent and divergent thinking. This positively influences team innovation performance.

Conclusion

How do team processes during convergent and divergent thinking in design thinking influence innovation performance? The DT team is a problem-solving and task-oriented group, employing specific methods and discipline to achieve a common goal. How the DT operates with regard to team processes has received little attention in past research (Liedtka, 2018) and may arguably be a reason for the mixed results in employing the method. The implicit assumption has been that a team that collaborates around the method achieves high performance, yet team performance has received little attention. The promise of DT as a social technology (Rao, et al., 2021) is considerably more com-plex than just aggregating individual behaviors. My study shows that DT may indeed function as a social technology (Tschimmel, 2022), but that there are important team processes associated with this. The DT team that performs is disciplined, structured, and honest, even in their approach to creativity. The important keyword here is transitioning between divergent and convergent thinking, which translates well into team processes known to be important for innovation performance. I find that DT as a method con-tributes to balancing divergent and convergent thinking as an iterative process with the goal of solving a problem for an end user as well as coming up with new solutions. The DT method not only combines well with well-known team performance factors related to innovation, but it may enhance and enable them. This hinges upon team processes of authority and discipline to stick with the process and psychological safety in the form of honest team reflexivity as an open dialogue. Team processes dedicated to building a

supportive climate and team cohesion may, on the other hand, hinder the usefulness of DT regarding innovation performance.

Practical implications

Teams that want to improve their innovative performance may learn valuable lessons from the DT team. Firstly, teams may benefit from the DT method of visualization by getting it routinized from the start. This ensures that all individual meanings are presented as a tool to obtain shared mental models (Heldal & Sjøvold, 2021). This may very well be seen in conjunction with brainstorming as a method of expanding the number of possible solutions. Secondly, the iterations between convergent and divergent thinking influence important team dynamics. Teams in general seek conformity and thus simple ways of thinking, which imposed iterations may challenge (ibid.). Innovative performance requires both creativity (divergent thinking) and discipline (convergent thinking). Thirdly, involving external actors or stakeholders (most notably prototyping with clients) in the innovation process ensures the best task resolution and also promotes the team flexibility needed for the necessary iterations between convergent and divergent thinking. It also promotes the team dynamics necessary for resolving complex problems (Sjøvold, 2022). An important practical implication for the DT team is to spend less energy on supportive and team-cohesive measures (team-building activities) from the start. DT as a method will take care of this need, and an overly strong emphasis may promote team conformity, thus preventing convergent thinking in later stages.

Research implications

The important implication for research is the understanding of the DT team not only as an aggregation of individual behaviors, but as a team with group dynamics. Results attest to the importance of group concepts such as team norms and psychological safety, which have previously not been paid proper attention to.

Limitations

The methodological setup has some strengths but also some weaknesses. The controlled environment could have been employed using control groups working with other methods than DT. Further, student groups may experience working environments differently than groups working with DT in real-life business settings.

Future research

Future research may answer the call of Anderson, Potonik, and Zhou (2014) to study live DT teams using some of our suggestions here. It could also be interesting to address how DT as a method could be employed in virtual teams, for instance through the use of electronic padlets. Last but not least, the concept of psychological safety in DT teams needs further attention. Future research may pay attention to enablers and disablers, how they relate to team leadership in DT teams, turn-taking (a DT concept not addressed in this study), and team conflicts.

Declarations

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