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ORIGINAL ARTICLE

Shaping Creativity: What Participants Say Works (and Doesn't) in Short-Term Educational Teams

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ABSTRACT

Creativity is a critical 21st century skill that generates innovative solutions to complex problems. This study examines participant perceptions on creativity during a three-week summer school where multidisciplinary teams developed novel applications for innovative technologies. Participants were surveyed on the effectiveness of the tools and techniques used. Findings highlight prototyping and external team interactions as major creativity enhancers. Relational rewards, breaks, and icebreakers were also perceived positively. However, certain tools such as supervisor influence and formal presentations were considered detrimental or ineffective. These findings offer practical insights for designing educational programs that stimulate creativity.

Keywords: Creativity; innovation; environment; education.

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INTRODUCTION

Creativity is a vital aspect of innovative thinking across various domains and is recognised as a crucial 21st-century skill (Kaplan, 2019; National Research Council, 2012). It promotes human potential and is imperative for societal progress in this rapidly evolving world (Bensalah & Mâță, 2022).

Early research on creativity focused on individual creativity, the "lone genius," and its predictors, such as personality traits. However, contemporary studies have increasingly highlighted the critical role of group dynamics in shaping creative outcomes, particularly in how collaboration fosters idea generation and problem-solving (Paulus & Nijstad, 2019).

Importantly, team creativity is shaped not only by individual factors but also by external elements, most notably the social environment (Amabile, 2012). Komarova et al. (2023) argue that creativity is not merely an internal process but is largely dependent on the sociocultural environment. Modifying external conditions may stimulate creativity more effectively than focusing solely on individuals' internal processes. Despite these insights, further research is needed to explore which specific social environment stimuli are more relevant for fostering creative output in teams.

To address this gap, we studied a unique educational initiative: a multidisciplinary programme between CERN and Delft University of Technology held in the summer of 2023, which brought together students from various Dutch universities to collaboratively tackle real-world societal challenges through creativity and innovation. Student teams were tasked with developing novel applications of emerging technologies, guided by the principles of design thinking. Educators intentionally introduced social environment stimuli to encourage creative ideation and implementation, particularly during brainstorming.

This context provides an excellent opportunity to investigate how managing social environment stimuli affects group creativity. Our research focuses on practical, instructor-led strategies and their impact on creativity in short-term educational programs. This paper addresses the following research questions:

(1) How do socio-environmental stimuli influence perceived creativity among participants in a short-term educational setting?

(2) How can these factors be effectively integrated into design thinking methodologies to enhance creative outcomes?

THEORETICAL BACKGROUND

This analysis is based on Amabile's (2012) definition of creativity as the generation of ideas or outcomes that are both novel and appropriate to a specific goal. According to Amabile, creativity is influenced by four key factors: three individual components (domain-relevant skills, creativity-relevant processes, and intrinsic task motivation), and one external component (the social environment).

Research into how social environment stimuli affect team creativity requires a clear understanding of group creativity. While some distinguish between group creativity and group innovation, we view both as integral stages within the broader creative process. Group creativity refers to the collective generation of ideas characterised by fluency, flexibility, originality, and elaboration. This process is shaped by cognitive and social factors, emphasising the critical role of interaction and shared knowledge (Komarova et al., 2023). Group innovation involves the collective process of transforming novel ideas into practical solutions (Linhardt & Salas, 2023). Despite this distinction, creativity and innovation are interdependent, with factors influencing one often affecting the other (Paulus & Nijstad, 2019).

The study examines how environmental stimuli influence creativity within the design thinking process, a problem-solving approach that combines analysis and creativity to develop human-centred, innovative solutions. A process where a supportive environment for collaboration, experimentation, and open-mindedness enhances creative outcomes throughout its stages: empathise, define, ideate, prototype, and test (Vikas et al., 2022).

Social environment stimuli measured

Amabile (2012) identifies key social environment factors that influence creativity: extrinsic motivators (such as awards and rewards), stimulating elements (like collaborative teams and supportive leadership), and obstacles (such as criticism of new ideas and excessive time pressure). Psychological safety, defined by Edmondson (2018) as the belief that one can speak up without fear of negative consequences, also functions as a key social stimulus that fosters open communication and creative engagement.

To further explore the theoretical background of this study, the following sections will examine the theoretical foundations of each technique studied within the context of the social environmental stimuli.

Extrinsic motivators

Amabile (2012) identifies extrinsic motivators as a social environment stimulus that can potentially enhance creativity when they confirm an individual's competence or enable deeper task engagement. Fischer et al. (2019) categorise them into two types:

- Transactional rewards are tangible rewards and refer to any form of financial compensation.
- Relational rewards are intangible. They include praise, recognition, and performance feedback.

Breaks and icebreakers

In ideation processes like brainstorming, fostering psychological safety is essential for success (Paulus, 2023). Two effective approaches for achieving this are breaks and icebreakers.

Brainstormers often conclude the ideation process prematurely, despite there still being more potential ideas to generate. Brief, intentional breaks allow participants' imaginations to operate freely, naturally enhancing overall creativity and boosting brainstorming sessions as a result (Griffiths & Medlicott, 2024).

Icebreaker activities have demonstrated effectiveness in enhancing participant engagement and motivation. Research shows these activities transform monotonous into dynamic learning environments, leading to a statistically significant increase in self-reported engagement levels among participants (Hoseini Shavoun et al.2024).

Prototyping and presentations

Rodriguez-Calero et al. (2023) emphasise that prototypes serve as shared mediums for designers and stakeholders, facilitating meaningful discussions about values and priorities through feedback and effective communication. This iterative engagement helps refine ideas and align expectations, fostering collaboration and improving design outcomes.

Similarly, Lee (2020) points out that learning occurs not only for students receiving feedback but also for peers who observe presentations and provide feedback. This process fosters critical thinking and continuous improvement, emphasising the interactive and collaborative nature of feedback during oral presentations.

Facilitator support

Given the challenges teams frequently encounter, they are likely to benefit from facilitator support. Facilitators act as architects of group interaction by fostering inclusivity, mediating conflicts, and steering group dynamics, ensuring cohesion while balancing diversity to optimise collaborative innovation (Mahajan, 2024.)

Facilitator support serves as a catalyst for both conflict management and psychological safety. Jones et al. (2024) emphasise that “psychological safety depends on an open acknowledgement of meaningful mistakes, so the facilitator also plays a key role in helping teams understand the risks that unacknowledged mistakes pose to team trust and successful research."

Peer support also plays a crucial role. Malmelin and Virta (2016) identify that spontaneous interaction, characterised by random and unplanned interactions between individuals, stimulates creativity.

In conclusion, the existing literature underlines the importance of the social environment defined by Amabile. This environment can be a powerful ally, if not a determinant or inhibitor, in the creative process.

METHODS AND DATA

Research Design

The primary objective of this study is to analyse and understand the influence of social environmental stimuli on team creativity, as depicted in Figure 1. The research employs a survey methodology to investigate participants' views on how specific techniques implemented in the summer programme, prioritising those that educators can directly control and modify, affected their creativity.

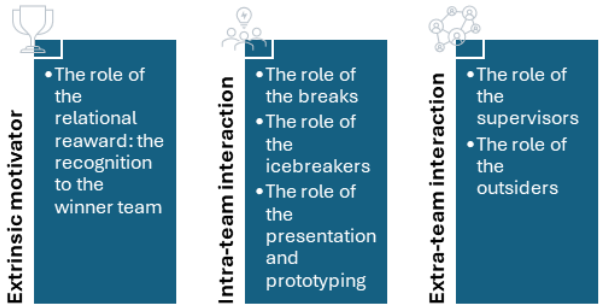

Fig. 1. Visual scheme of the surveyed techniques.

Participants

The study population comprised all students enrolled in the CERN IdeaSquare Summer Programme described in the Introduction (N = 20), with a response rate of 65% (n = 13). This resulted in a homogeneous sample of European university students, predominantly pursuing engineering degrees. No further selection criteria were employed, as the research aimed to investigate creativity within the specific context of this programme.

Instrumentation

A computer-assisted web interview (CAWI) was used to administer a seven-question survey. The first six were multiple-choice employing a Likert scale to measure levels of agreement or disagreement, with optional open-ended prompts to explore the motivations behind their responses. The final question was fully open-ended, inviting participants to share any additional factors they believe influenced creativity. This mixed-method design combined quantitative data from the Likert scale with qualitative data from the open-ended responses for both broad patterns and deeper insights.

Data Collection

Participation in the study was voluntary, and all responses were anonymised to ensure confidentiality. Over half of the respondents answered the open-ended questions, providing valuable qualitative data to complement the quantitative findings. This mixed-method approach captured both general trends and individual experiences.

Data Analysis

The analysis was conducted in two main stages:

1. Quantitative Analysis. Multiple-choice responses were analysed using automated tools available in Google Forms spreadsheets, enabling the identification of statistical patterns and trends across the dataset.

2. Qualitative Analysis. Open-ended responses were analysed manually through a systematic process:

- Initial Coding: Each response was individually reviewed and categorised into thematic groups (positive, negative, or neutral) based on its perceived impact on creativity.

- Thematic Synthesis: These initial categories were grouped to identify recurring patterns and emergent themes that enriched the understanding of the phenomenon under study.

Qualitative data helped corroborate and enrich the quantitative findings. For instance, open-ended responses provided context for interpreting participants' levels of agreement/disagreement measured by the Likert scale. This methodology facilitated a more comprehensive understanding by combining breadth (quantitative data) with depth (qualitative data), aligning with mixed-method principles such as convergent and explanatory sequential design.

RESULTS

Regarding the relational extrinsic motivator, eight out of twelve respondents reported that the prospect of winning influenced their creativity positively (Figure 2). The qualitative responses (n=10) analysis revealed two distinct patterns. Half attributed their increased focus and engagement to their inherently competitive nature, which was boosted by the prospect of a winning team. As one participant noted, "The winning team definitely had a great experience while being chosen." The other half were motivated by the intellectual challenge itself, rather than any external reward. One participant explained, "Competition for me represents a significant drive to bringing something to completion." Several participants also regretted only learning about the competition at the end of the program, suggesting earlier notice could have influenced their approach.

The remaining 50% felt strongly motivated to engage in problem-solving without any extrinsic motivators. Notably, several respondents regretted learning about the competition only after the programme ended.

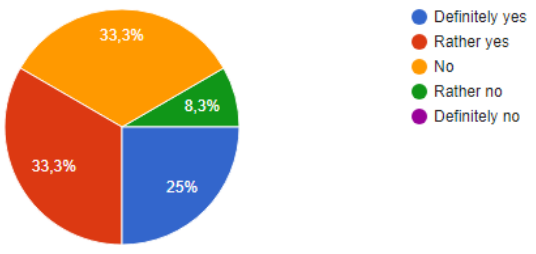

Fig. 2. Responses to whether choosing a 'winner' team was useful.

Regarding the team's dynamics at creating a comfortable ideation environment pro-creativity (Figure 3), most respondents (nine out of thirteen) felt positive about icebreakers. Of the seven qualitative responses, six respondents highlighted the icebreakers' usefulness in inspiring outside-the-box thinking, alleviating stress, stimulating creativity, and improving trust among team members. For example, one participant noted, "They were a breath of fresh air that would help in rebooting the brain." However, a minority expressed reservations, with one noting "They did affect my energy levels."

The impact of break duration on fostering creativity showed varied opinions (Figure 4). Quantitatively, five participants favoured having a few long breaks, citing reasons such as "less disruption to workflow" and the "potential for meaningful rest." In contrast, four respondents preferred a few short breaks, mentioning that their preferences were shaped by "past habits from school and university." Lastly, the other four participants were in favour of multiple short breaks, referencing the "Pomodoro technique as a proven method to enhance concentration and creative output."

The frequency of breaks is perceived as more influential on creativity than their duration. Most respondents (six out of nine) preferred fewer breaks, regardless of length, to maintain workflow continuity.

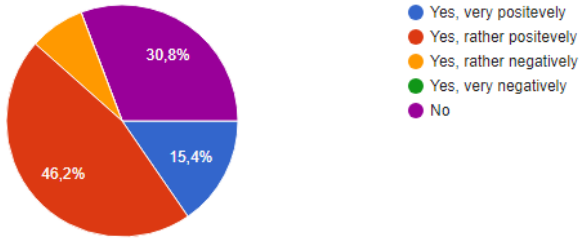

Fig. 3. Responses to whether the icebreakers influenced creativity.

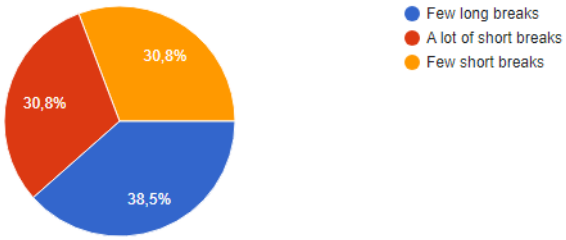

Fig. 4. Survey results regarding the preference break length and frequency for enhancing creativity.

Presentation and prototyping showed mixed results (Figure 5). Most participants (nine out of thirteen) indicated that presentation did not influence their creativity. Those who indicated an influence emphasised the creative aspects of slide design "rather than its impact on the creative development of the idea itself."

In contrast, prototyping was seen as significant by nearly all participants (Figure 6). All qualitative responses (n=7) agreed it encouraged multilateral thinking, new perspectives, and better understanding of its feasibility. One participant said, "Working hands-on really makes one think multilaterally." Only one mentioned a downside, saying prototyping occasionally discouraged certain ideas.

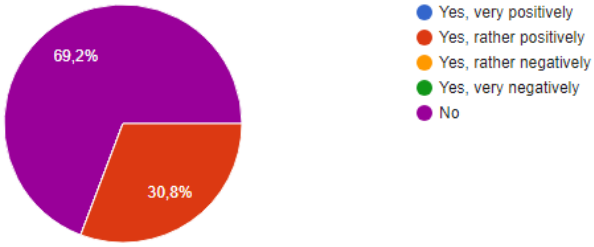

Fig. 5. Responses regarding the influence of the final presentation on their creative process.

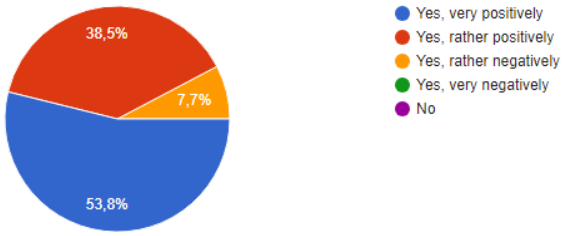

Fig. 6. Survey results regarding the impact of prototyping on the creative process.

External interaction with supervisors significantly impacted the creative process (Figure 7). Seven of the thirteen participants reported a negative influence, three saw no impact, and the rest indicated a positive effect. Qualitative responses (n=8) showed that "supervisor feedback was crucial", acting as either a stimulus or an obstacle. Five respondents appreciated that open, supportive supervisors, while three expressed dissatisfactions, citing frequent interruptions and negative comments that negatively influenced the group.

Nevertheless, interaction with individuals outside the team positively impacted creativity for twelve of thirteen participants (Figure 8). Of the qualitative responses (n=8), seven cited benefits like gaining new perspectives, distancing from the work, and receiving constructive feedback. Only one response expressed a "preference for dedicating that time to working directly on the idea."

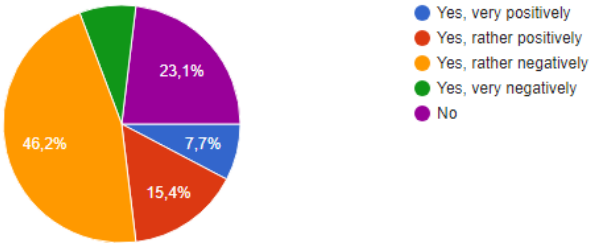

Fig. 7. Participants' perceptions of the supervisors' influence on creativity.

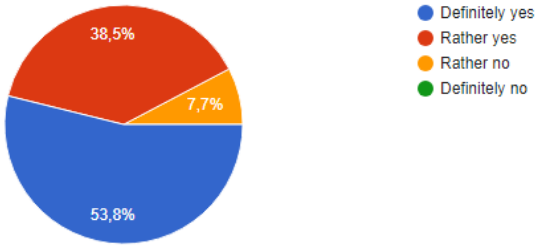

Fig. 8. Survey results on whether external discussions influenced participants' creativity throughout the ideation and design processes.

In summary, Figure 9 compares the positive quantitative results of the answers analysed.

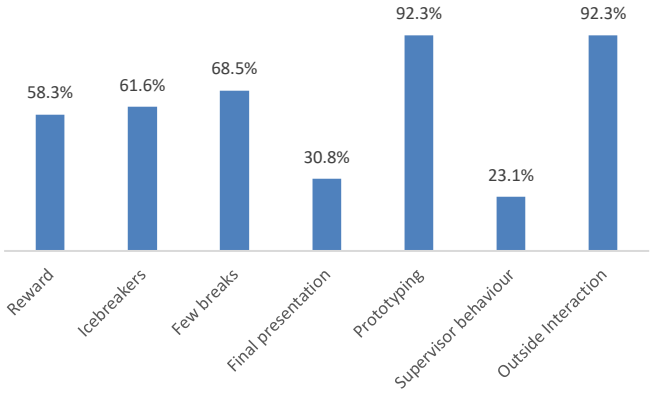

Fig. 9. Comparison of positive influence on creativity.

DISCUSSION AND CONCLUSIONS

Discussion

This study underscores how social environmental stimuli influence the perceived creativity among participants in the short term. Prototyping and external interactions most strongly enhance creativity, while extrinsic motivators, icebreakers, and breaks have minor positive effects. Supervisor behaviour had the greatest negative influence, and presentations had little impact.

However, it is essential to critically evaluate these findings due to methodological limitations of self-reported data, such as common method biases (CMBs) and the small, homogeneous sample. Podsakoff et al. (2003) highlight that self-reported data can be influenced by various biases, including social desirability, the consistency motif, or the tendency to answer consistently, even if it leads to false correlations, and the influence of transient mood states.

Social desirability bias may have led respondents to emphasise intrinsic over extrinsic motivators, as the former are often viewed more positively in academic settings. The consistency motif might explain why some reported that breaks disrupted "their workflow," despite evidence that breaks enhance creativity and engagement (Griffiths & Medlicott, 2024). Respondents' views on external interaction could also be influenced by their mood states at the time of the survey.

Additionally, external attribution bias (Bushong et al., 2023) might lead participants to blame supervisor behaviour for negative experiences. The identity-related bias (Brenner & DeLamater, 2016) may cause participants to overstate prototyping benefits to align with their creative or practical self-perception.

Despite efforts to minimise CMBs, such as respondent anonymity, surveys with both quantitative and qualitative questions, and rigorous data analysis, some bias may remain. This highlights the need to add observational measures to self-reported data in future research.

Nonetheless, our study shows clearly how social environment stimuli shape perceptions of team creativity in education and suggests ways educators can encourage creativity during the design thinking process.

In the **empathy stage,** supervisors should act as facilitators, tailoring their support to each team member's needs. Our results corroborate Amabile's research (2012) by confirming that supportive supervisors are crucial for fostering creativity. Starting sessions with well-designed icebreakers helps create a safe where participants feel comfortable sharing ideas and observations. This is consistent with Amy Edmondson's principle of psychological safety.

Our research emphasises external engagement. While previous studies have explored spontaneous creative interactions in organisational settings (Malmelin & Virta, 2016), our findings extend this concept to academic environments where unexpected encounters with outsiders catalyse co-ideation processes. This can be applied to the **define stage** where cross-team workshops and structured peer feedback enhance communication and idea evaluation.

In the **ideation stage**, well-structured brainstorming with guided icebreakers and breaks can optimise focus and creativity. Model simulations by Paulus et al. (2006) suggest that breaks during brainstorming benefit convergent more than divergent thinkers. Our findings suggest, as most participants preferred fewer breaks,

educators should provide flexible break options to accommodate different thinking styles. Hybrid divergence techniques, combining classic methods with external input, can further enrich group thinking. Our study also found that being on the winning team increased creativity, announcing incentives at this stage can motivate participants, in line with Fischer et al. (2019).

Our results have highlighted that prototyping plays a crucial role in iterative creative development (as argued by Rodriguez-Calero et al., 2023), especially in educational settings. Adopting an interactive approach during the **prototyping stage**, along with structured assessment and feedback for each iteration, should help participants evaluate originality and technical feasibility. This process also fosters creative resilience and strengthens the design process.

Finally, in the **testing stage**, result validation is critical and can be achieved through evaluation committees that include external interaction and cascading feedback systems to ensure constructive input and prevent analysis paralysis.

Conclusion

This study provides significant insights into the social environment stimuli that influence the perceived team creativity within an educational context. Our findings provide a foundation for integrating social environment stimuli management into the design thinking methodology, potentially enhancing its efficacy in fostering team creativity. Educators and facilitators can leverage these findings to create more conducive environments for creative thinking and innovation. It highlights the importance of bringing the supervisor's role closer to a facilitator, promoting free communication with outsiders, and optimising the number and duration of breaks and the quality and timing of icebreakers to align with the team's creative impulse.

By implementing these strategies alongside established training methods (brainstorming), educators and facilitators can create an environment that not only fosters creativity but also promotes self-realisation within the creative process. This approach places participants in an optimal position for creative openness and innovation.

While this study provides valuable insights, it is important to acknowledge its limitations. The relatively small and homogeneous sample size, along with our reliance on self-reported survey data, may introduce biases and limit the generalisability. These limitations point to several promising avenues for future research.

To improve generalisability, one crucial direction for further investigation is to explore the persistence of our results across large and diverse team compositions. Including participants from varied backgrounds and disciplines, comparing teams dominated by designers, business professionals, or engineers could yield valuable insights. Such research would enable educators to appropriately manage social stimuli based on team composition and context.

Future studies should combine self-reported data with objective measures, such as external evaluations of creative outputs. This approach would help mitigate the limitations inherent in self-reporting and provide a more comprehensive understanding of creative processes.

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REFERENCES

Amabile, T. M. (2012). *Componential Theory of Creativity*. Harvard Business School Working Paper, No. 12-096.

Bensalah, H., & Mâță, L. (2022). Transition from Knowledge Acquisition to Competency Development: Creativity as 21st Century Skill within Educational Framework. *Journal of Innovation in Psychology, Education and Didactics*, 26(2), 241-250. https://doi:10.29081/JIPED.2022.26.2.09

Brenner, P. S., & DeLamater, J. (2016). Lies, Damned Lies, and Survey Self-Reports? Identity as a Cause of Measurement Bias. *Social Psychology Quarterly*, 79(4), 333–354. https://doi.org/10.1177/0190272516670735

Bushong, B., & Gagnon-Bartsch, T. (2023). Reference dependence and attribution bias: Evidence from real-effort experiments. *American Economic Journal: Microeconomics*, 15(2), 271–308. https://doi.org/10.1257/mic.20210207

Edmondson, A. C. (2018). *The fearless organization: Creating psychological safety in the workplace for learning, innovation, and growth*. John Wiley & Sons.

Fischer, C., Malycha, C. P., & Schafmann, E. (2019). The influence of intrinsic motivation and synergistic extrinsic motivators on creativity and innovation. *Frontiers in Psychology*, 10, 137. https://doi.org/10.3389/fpsyg.2019.00137

Griffiths, C., & Medlicott, C. (2024, October 14). *Why your brainstorming sessions fail: How to unlock your team's true creative potential*. Training Journal. Retrieved April 10, 2025, from https://www.trainingjournal.com/2024/content-type/features/why-your-brainstorming-sessions-fail-how-to-unlock-your-teams-true-creative-potential/

Hoseini Shavoun, A., Adeli, S. H., & Ahmari-Tehran, H. (2024). Fostering engagement: A review of icebreakers in academic environments. *Medical Education Bulletin*, 5(2), 949–959. https://doi.org/10.22034/MEB.2024.495642.1105

Jones, M.S., Cravens, A.E., Zarestky, J., Ngai, C., & Love, H. B. (2024). Facilitating psychological safety in science and research teams. *Humanities and Social Science*

Communication, 11, 1632. https://doi.org/10.1057/s41599-024-04037-7

Kaplan, D. E. (2019). Creativity in education: Teaching for creativity development. *Psychology*, 10(2), 140-147. https://doi.org/10.4236/psych.2019.102012

Komarova, M., Ivanova, A., Petrova, N., & Sidorov, D. (2023). Group dynamics and creativity: a research with young adults in Reggio Emilia, Italy. *Creativity Studies*, 16(1), 297–314. https://doi.org/10.3846/cs.2023.17564

Lee, C. (2020). Qualitative Oral-Presentation Feedback: Comparisons from Business Professionals, Instructors, and Student Peers. *SAGE Open*, 10(1), 1–15. https://doi.org/10.1177/23294906221120015

Linhardt, R. M., & Salas, E. (2023). Examining the fluidity of innovation teams: a conceptual framework. *Frontiers in Psychology*, 14, 1296651. https://doi.org/10.3389/fpsyg.2023.1296651

Mahajan, S. (2024). Navigating the cohesion-diversity trade-off: Understanding the role of facilitators in co-creation using agent-based modelling. *Philosophical Transactions of the Royal Society A: Mathematical, Physical and Engineering Sciences*, 382(2262). https://doi.org/10.1098/rsta.2024.0093

Malmelin, N., & Virta, S. (2016). Organising creative interaction: Spontaneous and routinised spheres of team creativity. *Communication research and practice*, 3(4), 299-318. https://doi.org/10.1080/22041451.2016.1229296

National Research Council (2012). *Education For Life And Work: Developing Transferable Knowledge And Skills In The 21st Century*. The National Academies Press.

Paulus, P. (2023). The Role of Psychological Safety in Team Communication: Implications for Human Resource Practices. *Golden Ratio of Mapping Idea and Literature Format*, 3(2), 156–166. https://doi.org/10.52970/grmilf.v3i2.399

Paulus, P. B., Nakui, T., Putman, V. L., & Brown, V. R. (2006). Effects of task instructions and brief breaks on brainstorming. *Group Dynamics: Theory, Research, and Practice*, 10(3), 206-219. https://doi.org/10.1037/1089-2699.10.3.206

Paulus, P. B., & Nijstad, B. A. (2019). Introduction. En P. B. Paulus & B. A. Nijstad (Eds.), *The Oxford Handbook of Group Creativity and Innovation* (pp. 2–8). Oxford UniversityPress. https://doi.org/10.1093/oxfordhb/9780190648077.013.1

Paulus, P. B., & Nijstad, B. A. (2003). Group creativity: Innovation through collaboration. *Oxford University Press*. https://doi.org/10.1093/acprof:oso/9780195147308.001.0001

Podsakoff, P. M., MacKenzie, S. B., Lee, J.-Y., & Podsakoff, N. P. (2003). Common method biases in behavioral research: A critical review of the literature and recommended remedies. *Journal of Applied Psychology*, 88(5), 879–903. https://doi.org/10.1037/0021-9010.88.5.879

Rodriguez-Calero, I., Daly, S. R., Burleson, W., & Sienko, K. H. (2023). Prototyping strategies to engage stakeholders during early stages of design: A study across three design domains. *Journal of Mechanical Design*, 145(1), 011401. https://doi.org/10.1115/1.4056815

Vikas, T. N., Sreejith, S., & Suresh, M. (2022). Design thinking: A review paper. *International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)*, 2(2), 405–407. https://doi.org/10.48175/IJARSCT-2893