Metacognition in Design and Design Education

Tessa Forshaw; Eileen McGivney; Richard Cox Braden
The Next Level Lab, Harvard University

Reflection is a common strategy in design work and design-based research. To leverage it most effectively, we need to explore the elements that make it meaningful:

1. Metacognition involves being aware of and understanding one's own thought processes, including the patterns behind them and the elements that influence them. It involves higher-order thinking skills that enable individuals to plan, monitor, and assess their learning and understanding.
2. Reflection that is metacognitive generally involves thinking about emotions, motivation, knowledge, conceptions, ideas, strategies, and contexts. Not all reflection is metacognitive.
3. Metacognition helps designers monitor and control their cognitive processes for effective strategies and abandon ineffective ones. Because design is fundamentally an iterative and flexible process, utilizing metacognition is especially helpful to identify patterns and improve design over iterations and contexts.
4. Research shows that metacognitive reflection is an effective strategy for designers to improve their design process and design work.
5. The literature on learning and metacognition is very applicable to design, since design is a process of learning, exploration, and performance.

Forms of Metacognition (Grotzer, 2023)

- awareness of thinking, emotions, motivation, and knowledge.
- describing thinking, emotions, motivation, and knowledge.
- evaluating thinking, emotions, motivation, and knowledge.
- monitoring thinking, emotions, motivation, and knowledge.
- reflecting on and managing one's engagement in the types of thinking that tasks require.
- reflecting on and managing the social contexts related to one's metacognition.

As design researchers, we have to:

- self-regulate our thinking, learning, and actions.
- decide on appropriate methods, approaches, and strategies.
- consciously track our instincts, biases, and decisions, and how they impact whose voices or what systems and structures we are elevating.
- modify our design spaces and monitor our success in situ.
- evaluate our outcomes and determine if our design choices helped us meet our goals.

To do these things, we need to improve our capacity for this kind of reflection. One way to increase capacity for metacognitive reflection is to notice how to transform one's reflective practice to the meta-level.

Good metacognitive reflection questions tend to:

- encourage self-awareness and self-monitoring.
- evaluate strengths and weaknesses in thinking.
- promote transfer of learning to new contexts.
- be specific and actionable.

Research Summary on Metacognition in Design and Design Education

1. Metacognition is an essential part of the design research process and enhances skills design researchers use, such as ideation, development, and problem-solving (Kavousi, 2020). Students who are metacognitive tend to perform better on these tasks (González-Tobón et al., 2019).

2. People are able to learn metacognition (e.g., Dignath & Büttner, 2008; Kramarski & Mevarech, 2003). This is very true for design students as a specific cohort, where teaching metacognition has been shown to improve design metacognition (Adams et al., 2003; Crismond & Adams, 2012).

3. Research consistently shows that incorporating metacognitive practices into learning experiences improves outcomes, both in design and more broadly. For instance, in primary and secondary schools, incorporating metacognition into the curriculum had a weighted effect of 0.69 ($p < 0.01$) (Dignath & Büttner, 2008). In design students, metacognitive interventions have been shown to improve design students' ability to accurately self-evaluate their design process work (Daley et al., 2014) and to lead to better design performance (Adams et al., 2003).

4. High-performing design students tend to spend more time engaged in metacognitive thought processes such as planning, monitoring, and evaluating their approach to design work than low-performing students (Kavousi et al., 2020).

5. Metacognition plays an essential role in the process of learning transfer, especially in developing the sensitivity and inclination of when to transfer and strategies for how to abstract knowledge and apply it in new contexts (Grotzer & Forshaw, 2021). In one study, students who demonstrated higher levels of metacognition were more likely to transfer and accounted for a substantial portion (27%, $F = 4.73$, $p = .05$) of the differences in transfer observed between students (Grotzer & Mittlefehldt, 2011). The ability to transfer learning is an essential tool in a designer's toolkit since design problems are often ill-defined and complex, requiring designers to draw upon knowledge from various domains and contexts.

6. Metacognition allows people to understand how they select and deploy cognitive processes to navigate the inherent uncertainty of ill-defined, real-world design problems (Cuzzolino & Grotzer, 2022). By being aware of their cognitive processes, designers can carefully choose strategies that enable them to effectively progress from an ill-defined problem to a high-quality design solution despite the uncertainty involved (Ball & Christensen, 2019)

7. Metacognitive components help people understand their creative strengths and weaknesses and the creative context. This understanding promotes self-regulation and adaptive strategies during creativity, improving design problem-solving and innovation (Jia et al. 2019).

8. Design is cognitively challenging and requires overcoming several cognitive traps, such as top-down processing, confirmation bias, and fixation. Metacognition can help identify and overcome these obstacles (Butler & Roberto, 2018; Maymin & Langer, 2021)

9. A major limitation in leveraging the benefits of metacognition and metacognitive knowledge comes from not being sensitive to occasions that call for its application (Langer, 1989; Perkins et al., 1993). This can be incredibly problematic for designers, who often operate in unknown and uncertain contexts and thus need to be open to a wide variety of cues that could take on many forms.

10. We could use significantly more literature on metacognition and design to help us further the body of knowledge on design cognition.

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DRS Conference Metacognitive Reflection Worksheet:

Starting The Conference:	**My Reflection:**
What specific strategies will you use to actively engage with speakers and content during sessions (e.g., note-taking, questioning)? How will you monitor and adjust these strategies to ensure they are effective throughout the conference?	
What specific learning objectives do you have for this conference? How will you know if you have achieved them?	
What deeper personal or professional growth goals are motivating you to attend this conference? How will you track your progress toward these goals during and after the event?	
What prior experiences, knowledge, or perspectives do you bring that can enhance your understanding of the topics? How can you strategically use these assets to connect more deeply with the content?	
What potential challenges do you anticipate during the conference (e.g., information overload, networking difficulties)? How will you prepare to address these challenges?	

After Each Day of The Conference:	**My Reflection:**
What were the key takeaways you grasped well, and which concepts remain unclear? What specific actions will you take to clarify these areas of confusion?	
How did the content relate to your existing knowledge and interests? What new connections for your prior knowledge did you identify?	
What unexpected insights or new perspectives did you gain? How do these insights change your understanding?	
What actionable commitments or next steps did you identify today that you will implement in	

your work or research? How will you ensure these commitments are followed through?	
What strategies or approaches helped your comprehension and engagement the most? Which ones were less effective, and how can you modify them?	
How did you feel throughout the day's sessions? What moments or interactions contributed to these feelings, and how did they impact your learning?	

Towards The End of The Conference:	**My Reflection:**
Looking back on your primary goals for attending the conference, what evidence indicates you made progress in those areas? Where did you fall short, and why?	
What new insightful questions emerged from this experience that you want to continue investigating or discussing? How will you pursue these inquiries?	
How can you build upon or apply the specific knowledge or ideas gained at this conference to enhance your current research, teaching, or professional work? What are the first steps you will take to integrate these insights?	
How engaged were you during the sessions? What factors influenced your level of engagement, and how can you address these factors in future?	
How did you adapt your strategies when faced with unexpected challenges? What did you learn from these adaptations?	
How do you anticipate the knowledge and connections gained at this conference will impact your long-term professional development? What specific actions will you take to sustain this impact?	