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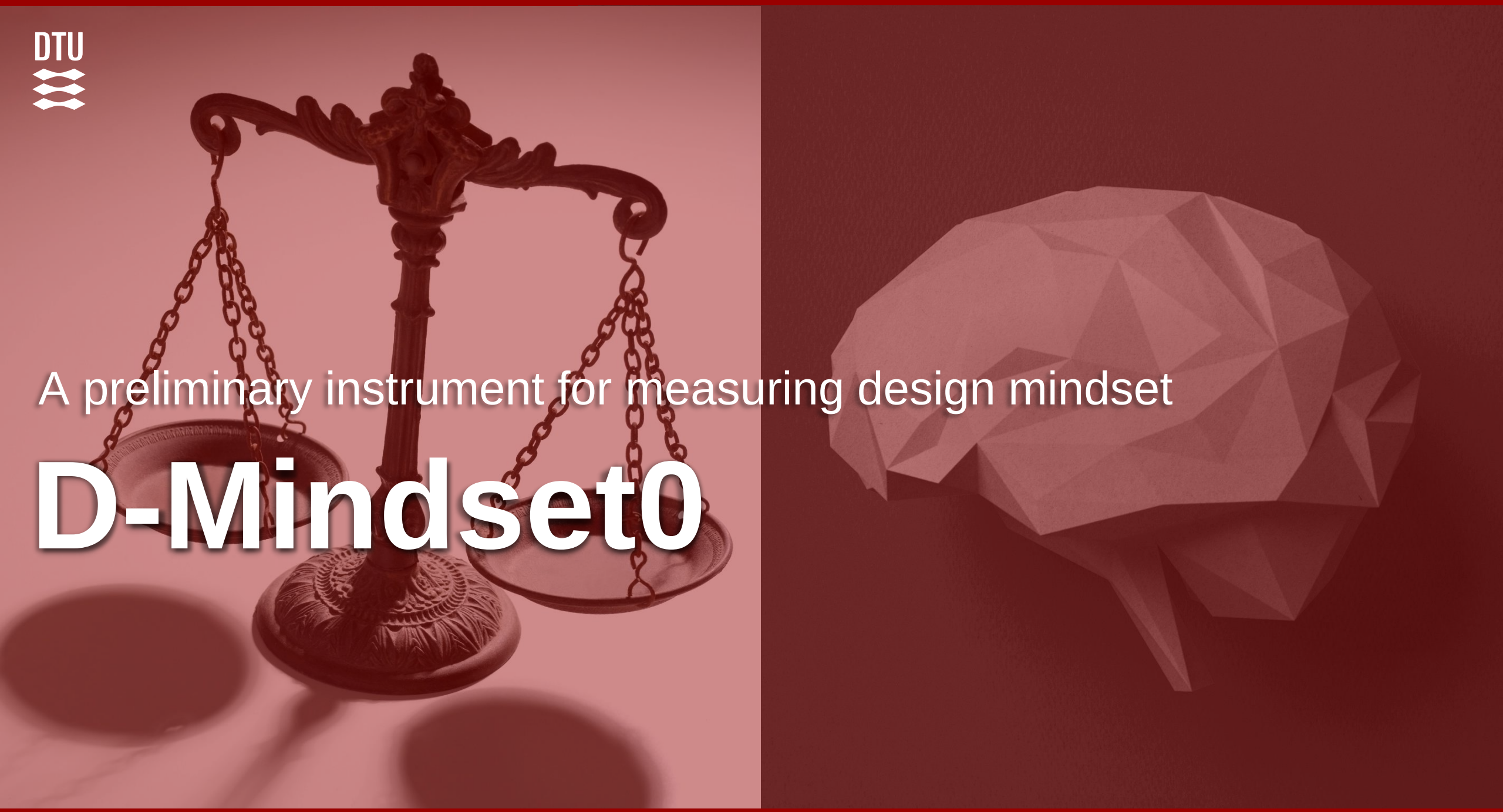

A preliminary instrument for measuring design mindset

D-Mindset0

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Researching design methods and their influence on the cognitive processes of designing.

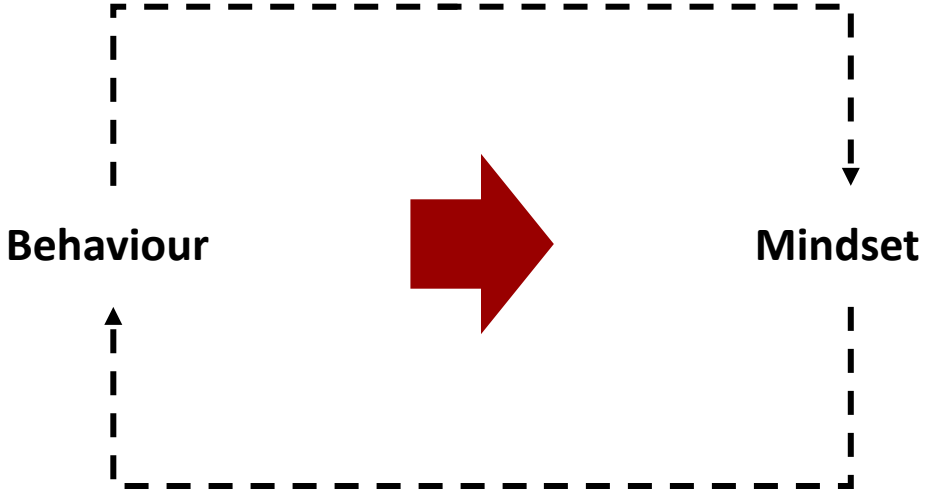
How to measure design mindset

1. What is design mindset?
2. Operationalization of design mindset
3. The Design mindset inventory (D-Mindset0)
4. The four underlying factors
5. Future research

Design mindset

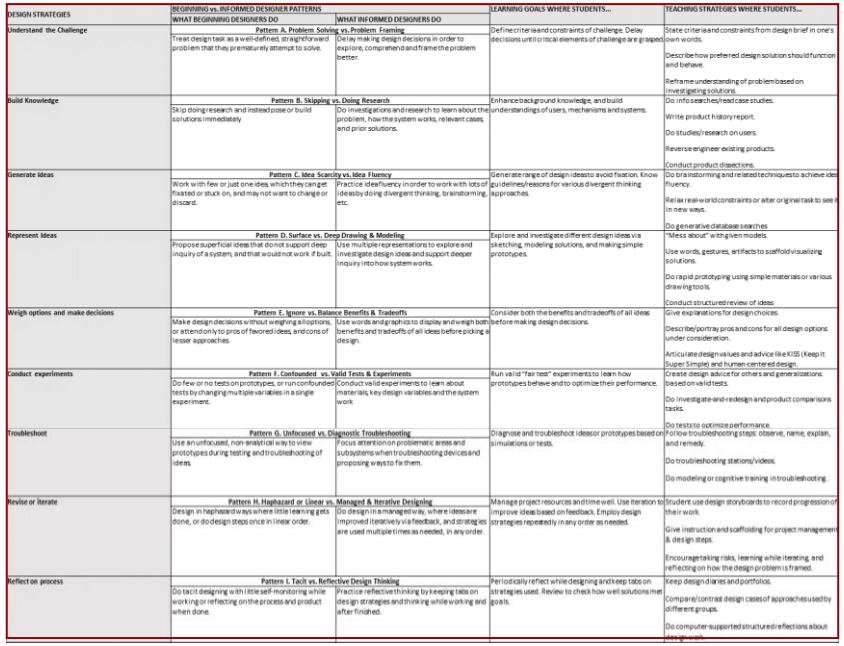
Design mindset is the beliefs and attitudes that determine the interpretation and understanding of design situations and the choice of appropriate design strategies, i.e., ***the mindset that aligns with effective design practices.***

Mindset > Behaviour



Operationalization

The Informed Design Teaching and Learning Matrix



DESIGN STRATEGIES	BEGINNING vs. INFORMED DESIGNER PATTERNS WHAT BEGINNING DESIGNERS DO	 WHAT INFORMED DESIGNERS DO	LEARNING GOALS WHERE STUDENTS...	TEACHING STRATEGIES WHERE STUDENTS...
Understand the Challenge	Pattern A. Problem Solving vs. Problem Framing Treat design task as a well-defined, straightforward problem that they prematurely attempt to solve.	Delay making design decisions in order to explore, comprehend and frame the problem better.	Define criteria and constraints of challenge. Delay decisions until critical elements of challenge are grasped.	State criteria and constraints from design brief in one's own words. Describe how preferred design solution should function and behave. Reframe understanding of problem based on investigating solutions.
Build Knowledge	Pattern B. Skipping vs. Doing Research Skip doing research and instead pose or build solutions immediately	Do investigations and research to learn about the problem, how the system works, relevant cases, and prior solutions.	Enhance background knowledge, and build understandings of users, mechanisms and systems.	Do info searches/read case studies. Write product history report. Do studies/research on users. Reverse engineer existing products. Conduct product dissections.
Generate Ideas	Pattern C. Idea Scarcity vs. Idea Fluency Work with few or just one idea, which they can get fixated or stuck on, and may not want to change or discard.	Practice idea fluency in order to work with lots of ideas by doing divergent thinking, brainstorming, etc.	Generate range of design ideas to avoid fixation. Know guidelines/reasons for various divergent thinking approaches.	Do brainstorming and related techniques to achieve idea fluency. Relax real-world constraints or alter original task to see it in new ways. Do generative database searches
Represent Ideas	Pattern D. Surface vs. Deep Drawing & Modeling Propose superficial ideas that do not support deep inquiry of a system, and that would not work if built.	Use multiple representations to explore and investigate design ideas and support deeper inquiry into how system works.	Explore and investigate different design ideas via sketching, modeling solutions, and making simple prototypes.	"Mess about" with given models. Use words, gestures, artifacts to scaffold visualizing solutions. Do rapid prototyping using simple materials or various drawing tools. Conduct structured review of ideas
Weigh options and make decisions	Pattern E. Ignore vs. Balance Benefits & Tradeoffs Make design decisions without weighing alloptions, or attend only to pros of favored ideas, and cons of lesser approaches.	Use words and graphics to display and weigh both benefits and tradeoffs of all ideas before picking a design.	Consider both the benefits and tradeoffs of all ideas before making design decisions.	Give explanations for design choices. Describe/portray pros and cons for all design options under consideration. Articulate design values and advice like KISS (Keep It Super Simple) and human-centered design.
Conduct experiments	Pattern F. Confounded vs. Valid Tests & Experiments Do few or no tests on prototypes, or run confounded tests by changing multiple variables in a single experiment.	Conduct valid experiments to learn about materials, key design variables and the system work	Run valid "fair test" experiments to learn how prototypes behave and to optimize their performance.	Create design advice for others and generalizations based on valid tests. Do investigate-and-redesign and product comparisons tasks. Do tests to optimize performance.
Troubleshoot	Pattern G. Unfocused vs. Diagnostic Troubleshooting Use an unfocused, non-analytical way to view prototypes during testing and troubleshooting of ideas	Focus attention on problematic areas and subsystems when troubleshooting devices and proposing ways to fix them.	Diagnose and troubleshoot ideas or prototypes based on simulations or tests.	Follow troubleshooting steps: observe, name, explain, and remedy. Do troubleshooting stations/videos. Do modeling or cognitive training in troubleshooting
Revise or Iterate	Pattern H. Haphazard or Linear vs. Managed & Iterative Designing Design in haphazard ways where little learning gets done, or do design steps once in linear order.	Do design in a managed way, where ideas are improved iteratively via feedback, and strategies are used multiple times as needed, in any order.	Manage project resources and time well. Use iteration to improve ideas based on feedback. Employ design strategies repeatedly in any order as needed.	Student use design storyboards to record progression of their work. Give instruction and scaffolding for project management & design steps. Encourage taking risks, learning while iterating, and reflecting on how the design problem is framed.
Reflect on process	Pattern I. Tacit vs. Reflective Design Thinking Do tacit designing with little self-monitoring while working or reflecting on the process and product when done.	Practice reflective thinking by keeping tabs on design strategies and thinking while working and after finished.	Periodically reflect while designing and keep tabs on strategies used. Review to check how well solutions met goals.	Keep design diaries and portfolios. Compare/contrast design cases of approaches used by different groups. Do computer-supported structured reflections about design work.

Crismond, D. P., & Adams, R. S. (2012). **The Informed Design Teaching and Learning Matrix.** *Journal of Engineering Education*, *101*(4), 738–797. https://doi.org/10.1002/J.2168-9830.2012.TB01127.X

D-Mindset0

Items	
1	It is important to challenge the problem statement before trying to solve the problem.
2	Problems should be well-defined and fully understood before attempting to develop a solution. (reversed)
3	To improve the future, you should not try to solve today's problems but imagine a new future.
~~4~~	~~You should spend more time building the solution than understanding the question. (reversed)~~
5	It is more important to spend time generating many ideas than it is to refine a few.
6	As soon as you have a good idea, you should move from idea generation to idea refinement. (reversed)
7	Representing ideas in non-verbal ways, e.g., using diagrams, sketches, prototypes, and dramatization, is essential in understanding a problem.
8	Sharing ideas with others throughout the process makes them better.
9	It is important to look at a solution from different stakeholder perspectives.
10	Once you have a good idea, you should not waste time figuring out how it might fail. (reversed)
~~11~~	~~A failed experiment can be as important as a successful one.~~
~~12~~	~~Spending time testing continuously is more important than testing the end result.~~
~~13~~	~~Even late in the process, you should pivot and rethink a solution if learning something important.~~
14	If done right, you should not have to revisit past stages of the innovation process. (reversed)
15	Following a process is more important than adapting to the circumstances. (reversed)
~~16~~	~~Methods are more a guideline than rules you must follow.~~

Design strategy (behaviour) => Mindset

Understand the Challenge (Problem Solving vs. Problem Framing)
WHAT BEGINNING DESIGNERS DO
Treat design task as a well-defined, straightforward problem that they prematurely attempt to solve.
WHAT INFORMED DESIGNERS DO
Delay making design decisions in order to explore, comprehend and frame the problem better.

D-Mindset0	
ITEM 1	It is important to challenge the problem statement before trying to solve the problem.
ITEM 2	Problems should be well-defined and fully understood before attempting to develop a solution. (reversed)

Design strategy	Items	
Understand the challenge	1	It is important to challenge the problem statement before trying to solve the problem.
	2	Problems should be well-defined and fully understood before attempting to develop a solution. (reversed)
Build knowledge	3	To improve the future, you should not try to solve today's problems but imagine a new future.
	4	You should spend more time building the solution than understanding the question. (reversed)
Generate Ideas	5	It is more important to spend time generating many ideas than it is to refine a few.
	6	As soon as you have a good idea, you should move from idea generation to idea refinement. (reversed)
Represent Ideas	7	Representing ideas in non-verbal ways, e.g., using diagrams, sketches, prototypes, and dramatization, is essential in understanding a problem.
	8	Sharing ideas with others throughout the process makes them better.
Weigh options and make decisions	9	It is important to look at a solution from different stakeholder perspectives.
	10	Once you have a good idea, you should not waste time figuring out how it might fail. (reversed)
Conduct experiments	11	A failed experiment can be as important as a successful one.
	12	Spending time testing continuously is more important than testing the end result.
Revise or iterate	13	Even late in the process, you should pivot and rethink a solution if learning something important.
	14	If done right, you should not have to revisit past stages of the innovation process. (reversed)
Reflect on process	15	Following a process is more important than adapting to the circumstances. (reversed)
	16	Methods are more a guideline than rules you must follow.

Exploratory Factor Analysis

Item	Factor 1	Factor 2	Factor 3	Factor 4	Uniqueness
	Conversation with the situation	Iteration	Co-evolution of problem-solution	Imagination	
8	0.9249				0.3843
9	0.5482				0.5496
7	0.4583				0.7152
15		0.6668			0.5466
6		0.5848			0.7067
10		0.5273			0.6821
14		0.5112			0.7166
2			-0.6420		0.6643
1			0.4976		0.7013
5				0.5560	0.7041
3				0.4589	0.8118
4					0.8174
11					0.8122
12					0.8668
13					0.6967
16					0.8910

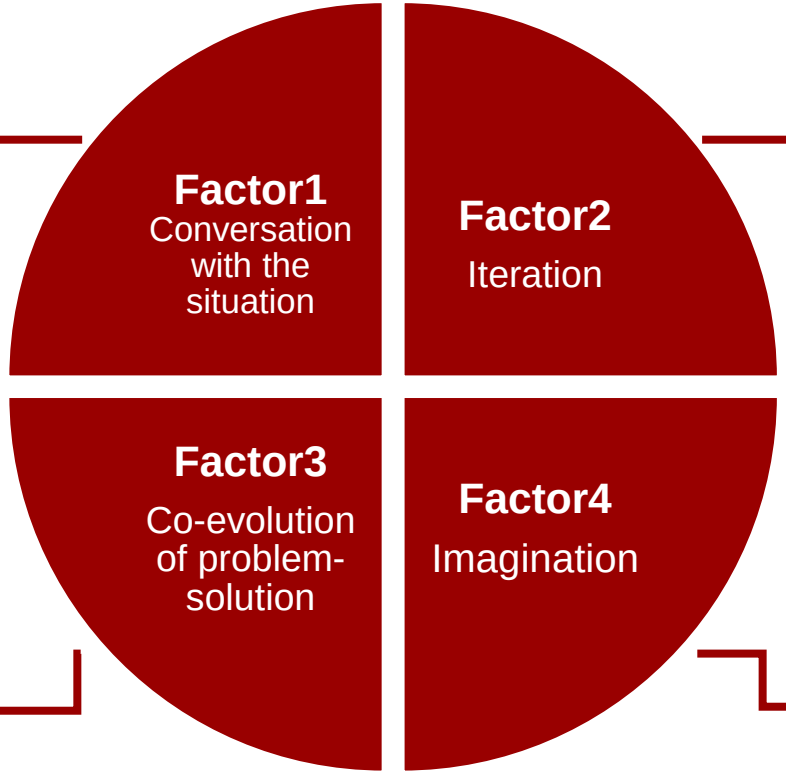
Note. Oblique rotation was used with the Promax criterion.

Evolution of the design mindset inventory

Strategy	Item	Factor
Undestand the challenge	1. It is important to challenge the problem statement before trying to solve the problem.	3. Co-evolution of problem-solution
	2. Problems should be well-defined and fully understood before attempting to develop a solution. (reversed)	
Build knowledge	3. To improve the future, you should not try to solve today's problems but imagine a new future.	4. Imagination (divergent theingking)
	4. You should spend more time building the solution than understanding the question. (reversed)	
Generate ideas	5. It is more important to spend time generating many ideas than it is to refine a few.	1. Conversation with the situation
	6. As soon as you have a good idea, you should move from idea generation to idea refinement. (reversed)	
Represent ideas	7. Representing ideas in non-verbal ways, e.g., using diagrams, sketches, prototypes, and dramatization, is essential in understanding a problem.	
	8. Sharing ideas with others throughout the process makes them better.	
Weigh options and make decisions	9. It is important to look at a solution from different stakeholder perspectives.	2. Iteration
	10. Once you have a good idea, you should not waste time figuring out how it might fail. (reversed)	
Conduct experiments	11. A failed experiment can be as important as a successful one.	
	12. Spending time testing continuously is more important than testing the end result.	
Revise or iterate	13. Even late in the process, you should pivot and rethink a solution if learning something important.	
	14. If done right, you should not have to revisit past stages of the innovations process. (reversed)	
Reflect on process	15. Following a process is more important than adapting to the circumstances. (reversed)	
	16. Methods are more a guideline than rules you must follow.	

Design Mindset

- Externalizing ideas to foster a 'conversation with the situation' and engage with stakeholders
- Makes assumptions explicit

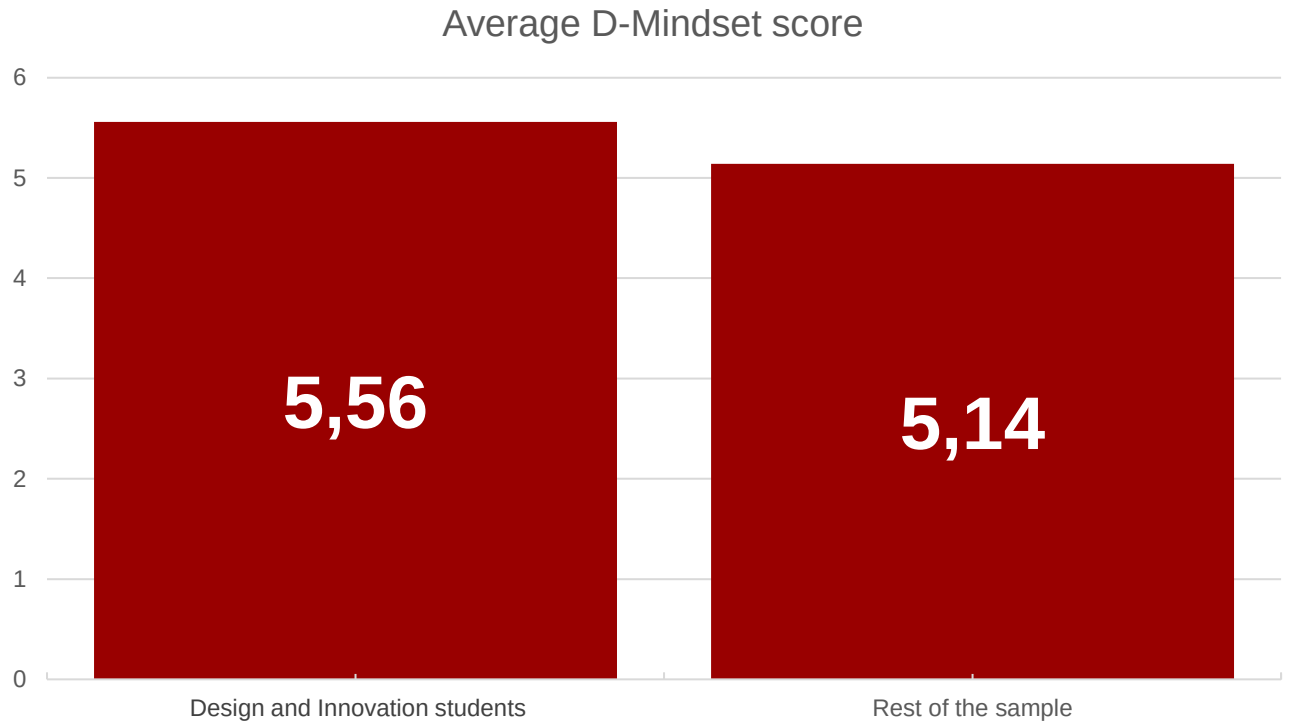


- Allowing feedback loops at both the idea and process levels
- Implement learning

- Framing and reframing the problem
- Suspend the decision on a solution
- Learning through experimentation
- Reducing assumptions

- Imagining new and different futures
- Actively stimulating divergent thinking to overcome fixation and explore unconventional ideas

Measures something to do with design…

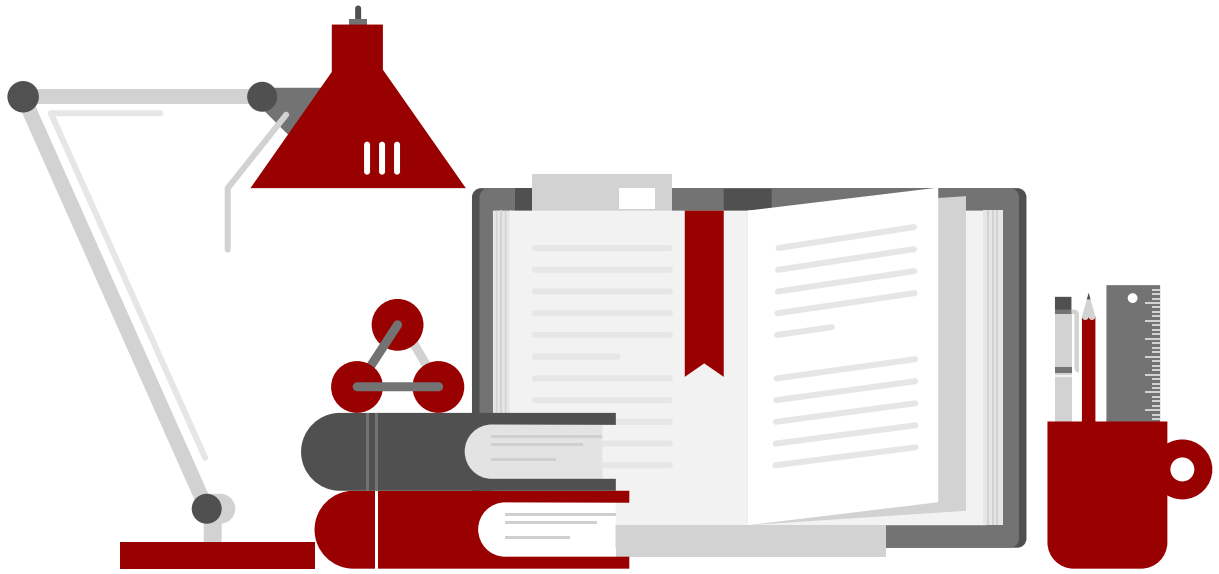


Reliability - Internal consistency

	McDonald's Omega (ω)
The inventory	**0.6884 [CI95% 0.64..0.73]**
Factor 1	**0.6541 [CI95% 0.59..0.71]**
Factor 2	**0.6464 [CI95% 0.57..0.70]**
Factor 3	0.4661 [CI95% 0.33..0.57]
Factor 4	0.3895 [CI95% 0.27..0.50]

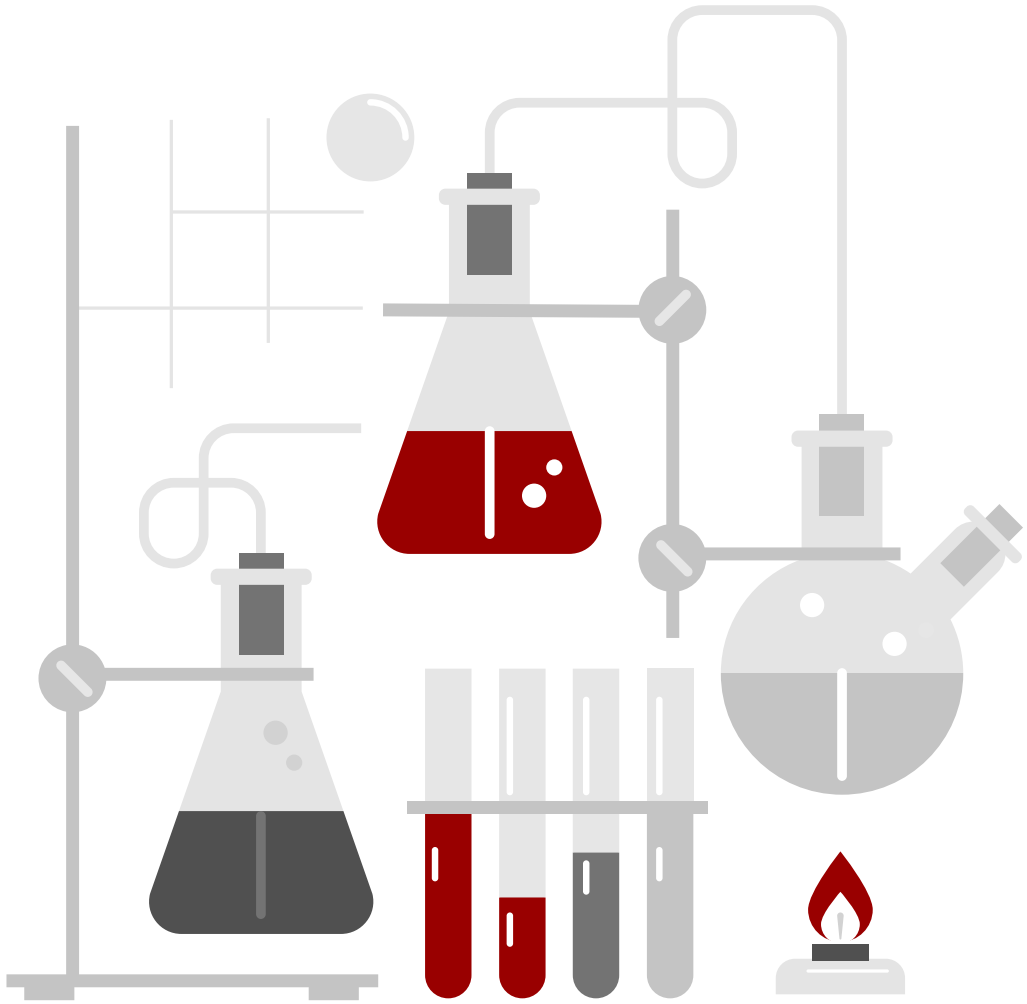
Summary

- 8 design strategies => 16 questions => 11 items => 4 Factors



Future research

- Further development of D-Mindset0
- Investigation into how design mindset is developed and influence design practice
- Investigation of the relationship between the different aspects of D-Mindset0 and the development of design mindset



Let’s go measure *design mindset*

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