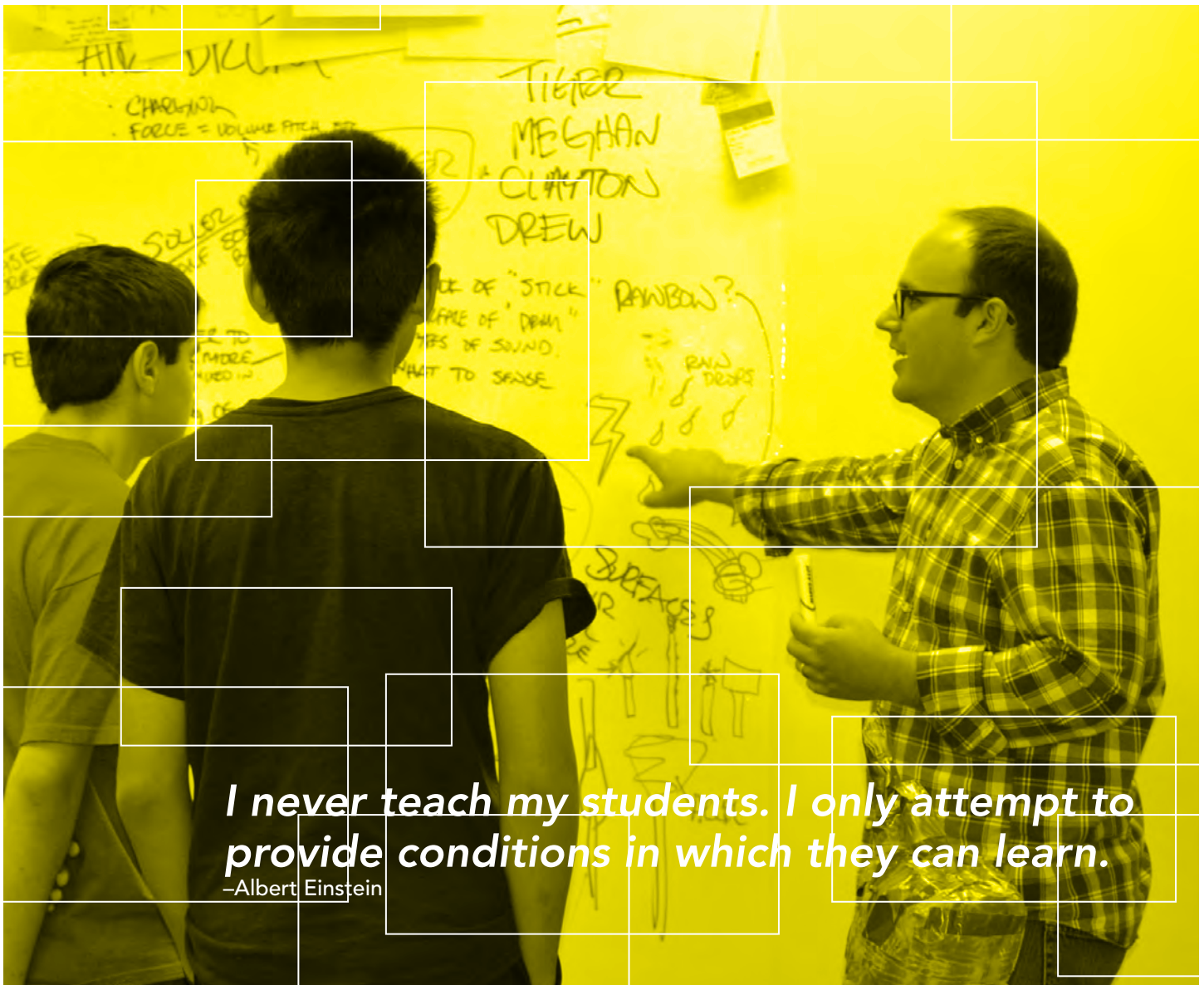INSTITUTE FOR
CREATIVITY,
ARTS, AND
TECHNOLOGY

Critical and Creative Thinking by Design

IDEA *Studio*

> *I never teach my students. I only attempt to provide conditions in which they can learn.*
> –Albert Einstein

About this booklet

This booklet is for educators who would like to learn more about how and why to incorporate methods to support development of students' critical and creative thinking skills. References and technical information about our research on this topic are summarized in:

Baum-Combs, L., Cennamo, K. S., & Newbill, P. L. (2009). Developing critical and creative thinkers: Toward a conceptual model of creative and critical thinking processes. Educational Technology, 49(5), 3-14.

This booklet also promotes a design-based learning environment as an ideal setting in which to help learners build these requisite skills. For links to all our work, please visit us on the web at http://www.icat.vt.edu/IDEAS/index.html.

About us

The IDEA Studio is dedicated to giving learners the time, space, and permission to think and do. We believe in providing students adequate time to explore their surroundings and identify relevant problems, space to collaborate with others and test their ideas, and permission to develop and test their potential solutions to the challenges they identify. We promote the development of critical and creative thinking skills and explore collaborative learning environments that emphasize the importance of the connections between and among disciplines. A transdisciplinary learning environment of this nature builds independent students who have the confidence and ability to tackle the challenges that lie before them.

The Relationship between Critical and Creative Thinking and Design
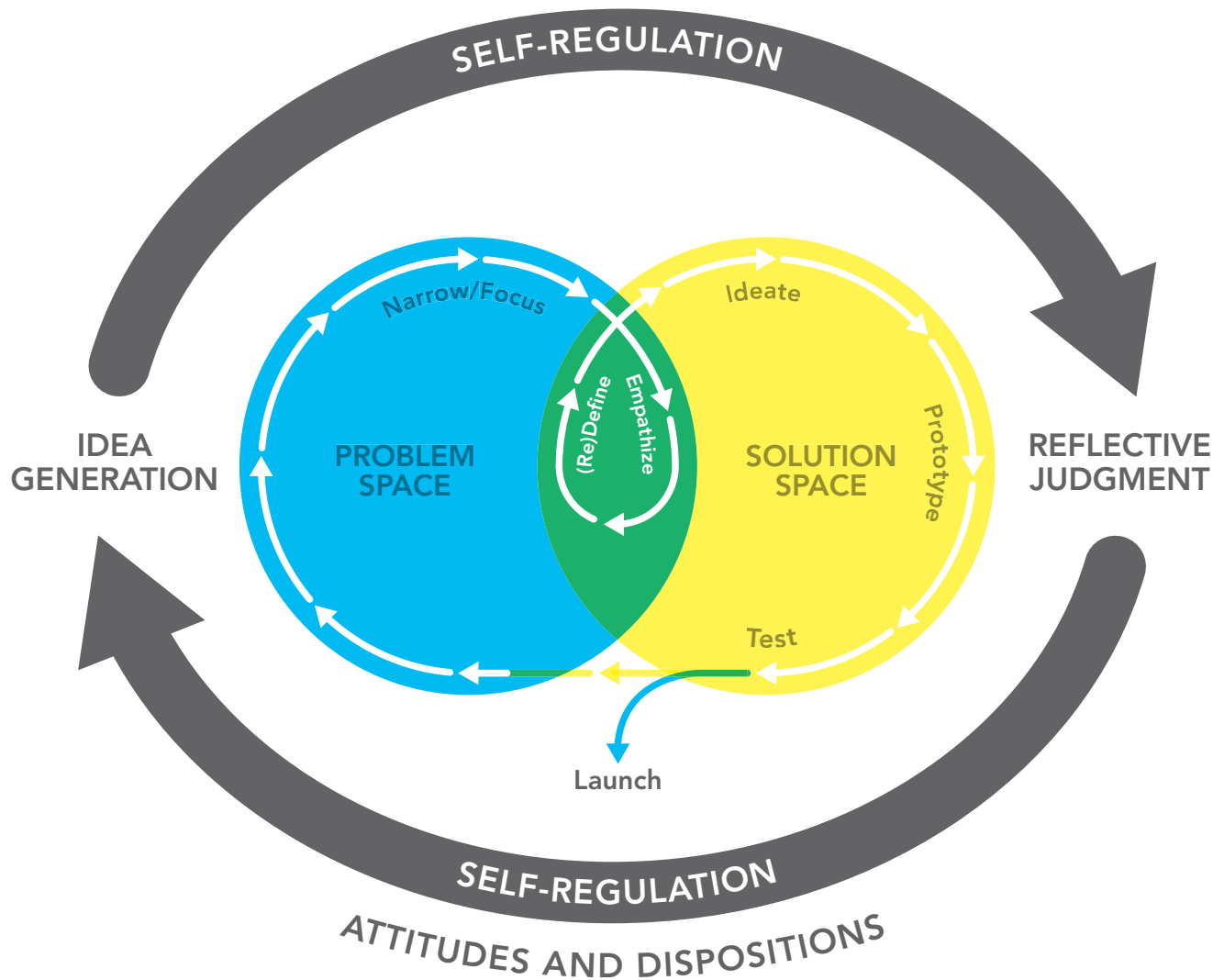
Critical and creative thinking is an integrated skill that involves generating and evaluating ideas around a core of knowledge. The idea generation and reflective judgment processes are monitored and controlled by self-regulation. Throughout the process, thinkers maintain the attitudes and dispositions that foster critical and creative thought. The model above illustrates the notion that designerly thinking is at the heart of critical and creative thought. Design is a unique form of problem solving that involves building solutions to problems that have no correct or pre-determined solution. As designers work through the problem space and the solution space of a design challenge, they utilize skills from each of the four components of critical and creative thinking.

Idea Generation

Many of the problems our students will be challenged to solve in the real world have no pre-determined solution. Effective problem solvers are able to recognize the existence of a challenge and identify potential solutions. Idea generation is about coming up with unusual ideas, whether they are realistic or outlandish. During idea generation, nothing is too wild or silly or impractical. Idea generation can be facilitated by working with new materials, visiting a new space, talking to people with different perspectives, brainstorming, building on other ideas, and comparing problem elements to other things. The more ideas are developed in this phase, the more probable a unique, practical, and effective solution will be found.

IN THE CLASSROOM, unique ideas result when idea generation is explicitly separated from other activities. It is also important that ideas are not judged. Give students public space to record their ideas themselves, as on a whiteboard or large paper. Allow time for idea generation.

Idea Generation:

Brainstorm: Define and record multiple solutions or ideas related to a topic.

Conceptualize: Use a variety of methods to verbalize or represent ideas.

Explore: "Play" with raw materials and stimuli related to a challenge; gain inspiration through a variety of tools, media, materials, and experiences.

Use analogies: Make associations and identify comparative relationships between two or more elements.

Use metaphors: Use a term or phrase as representative or symbolic of something to which it is not literally applicable in order to suggest a resemblance.

Examine ideas in new and varied ways: Engage in a variety of activities, take field trips, seek others' perspectives on a challenge.

Observe: Monitor things closely to identify details and procedures as they relate to a challenge; gather information; identify what is known and determine gaps in knowledge.

Elaborate: Expand on existing ideas and develop information beyond what is given.

Infer: Draw conclusions based on evidence and reasoning not explicitly stated.

Extrapolate: Learn information about one topic and apply it to another.

Make remote associations: Rapidly conceive of numerous novel possibilities.

Reflective Judgment

Students' worlds are full of access to information from a variety of sources. Their task is to not only find relevant information but also determine its utility within the context of their current challenge. Reflective judgment is about filtering and combining information and ideas to develop an effective solution. When using this component of critical and creative thinking, problem solvers consider their personal experience, outside resources, and other thinkers' input as they organize, combine, and separate information. Through this analytical process, they determine the best and most feasible plan to pursue.

IN THE CLASSROOM, students practice reflective judgment as they analyze, synthesize, and evaluate information from multiple sources. They work together to determine the best potential solution to a challenge and then try out that solution. Failure is as important as success in teaching reflective judgment skills because it offers new information that problem solvers must use to re-evaluate the challenge. Students need plenty of time and space for trying out multiple solutions.

Reflective Judgment:

Question: Ask questions to help evaluate and judge information; inquire to seek clarity and begin process of analyzing and evaluating.

Separate: Divide information into relevant and irrelevant components.

Organize: Consider all information and determine connections and relevancy within; sort information into categories that relate to the problem context.

Interpret: Derive meaning from information; add meaning to a situation or process.

Summarize: Condense larger ideas and combine isolated yet relevant information to make a cohesive and comprehensive unit; take information provided by others and restate it through personal connections and interpretations.

Hypothesize: Develop statements or conclusions to be tested or used for explanatory purposes; use as a plan for further investigation.

Compose: Use written or oral language, visuals, or other symbol systems to represent information.

Judge resources: Examine resources to determine the degree to which information is honest, fair, and relevant.

Judge logic: Identify how a claim was generated and the degree to which is it supported by reliable sources.

Judge value and worth: Determine how useful an idea is to both the thinker and the context.

Generalize: Develop principles and rules for applying information to other situations.

Self-Regulation

As thinkers engage in generating and refining ideas, they should maintain the ability to monitor their own learning and activity as well as the resources available to them. Self-regulation is the process through which individuals plan for learning, set personal goals, monitor progress, and make changes as needed. The skill helps build thinkers' self-efficacy, confidence, attitudes, and motivation.

IN THE CLASSROOM, students who take at least partial responsibility for setting their own goals and assessing their progress learn to build self-regulation skills. Given the permission and tools for planning, monitoring, and tracking their own learning, students gain confidence in their ability as they identify and improve on their strengths and weaknesses.

Self-Regulation:

Recognize the existence of a challenge: Recognize the challenge and understand its conditions and scope.

Assess knowledge: Assess current knowledge state and determine what is known and to what degree.

Understand ability: Understand one's own capabilities as they relate to the goal and the current context.

Allocate resources: Plan allocation of resources, including time.

Focus: Control the level and type of attention required to accomplish a task.

Perform: Judge the overall commitment, effort, and activity to achieve goals.

Progress: Maintain awareness of progression toward goals.

Identify consequences: Identify possible outcomes of judgments and reasoning; weigh consequences in relation to the goal.

Revise: Change course of action related to goal through monitoring of progress.

Cognitive restructuring: Make affirmative internal changes in how one perceives oneself relative to the context through self-talk; use internal affirmation through positive self statements to manage thinking processes.

Evaluate the process: Determine whether the processes used to generate results are in line with initial goals.

Evaluate the product: Determine whether the final product is relevant, appropriate, and valuable to the initial challenge and context.

Attitudes and Dispositions

Certain attitudes and dispositions are particularly helpful to thinkers working through a problem. The ability to tolerate ambiguity, consider others' perspectives, and avoid impulsivity are all key skills related to this aspect of critical thinking. Motivation, flexibility, and confidence are also necessary for the development of and continuous involvement in critical and creative thinking.

IN THE CLASSROOM, students with appropriate attitudes and dispositions are intrinsically and extrinsically rewarded for their flexibility, motivation, and perceptive behavior. Struggling students might need help understanding how their attitudes impact the quality of their work.

Attitudes and Dispositions:

Demonstrate autonomy: Demonstrate self-direction and discipline; self-initiate behaviors and actions.

Persist: Strive to work beyond the limits of one's own knowledge and persevere through the task.

Maintain intrinsic motivation: Work on a task because of personal pleasure or sense of satisfaction derived from performing the task rather than for external rewards.

Recognize relevance: Determine the personal relevance and significance of a context, challenge, or process.

Avoid impulsivity: Withhold judgments and exhibit skepticism; avoid rash decisions without seeking further clarity.

Reject stereotypes and prejudices: Avoid considering previously developed discriminations or hypotheses.

Embrace multiple points of view: Allow multiple perspectives to penetrate thinking; describe an idea through other perspectives and viewpoints.

Judge assumptions: Identify information thought to be true based on experiences; determine origin and validity of assumptions.

Remain sensitive: Be aware of and recognize the needs and positions of others and their surroundings.

Remain open-minded: Consider all external experiences, including senses, fantasy, aesthetics, feelings, and actions of others; remain curious and inquisitive about internal and external influences.

Tolerate ambiguity: Allow vaguely established ideas and perspectives to penetrate thinking.

Critical and Creative Thinking By Design

Design thinking is a mindset that requires many of the skills of critical and creative thinking. Designers work iteratively between the problem space - where they narrow the focus, investigate the needs of their audience, and restructure the problem as they gather new information - and the solution space - where they generate ideas for solutions, build and test models of those solutions, and ultimately offer a solution to the challenge. In each of these spaces, critical and creative thinking necessarily occur as the problem-solving process unfolds.

Problem Space

To narrow the focus and find relevant problems in their surroundings, designers often ask the question, "How might we...?" This phase of problem finding is an often overlooked part of the design process. Finding relevant, meaningful problems to solve is an important goal and a skill that must be practiced. The type of problem on which we choose to focus is a reflection of critical and creative thinking.

During the empathize phase, designers identify their target audience and work to develop a deep understanding of that audience's perspective. Most importantly, they listen, observe, interact, and ask questions (particularly, "Why?"), in order to learn as much as possible about the problem from the perspective of those who are impacted by it.

With a clearer understanding of the target audience's perspective, the designer must define or reframe the original design challenge from that new perspective. During this phase, the designer makes sense of the problem and works to remove any incorrect personal assumptions that may have been discovered through the empathy phase. Spending time in this phase helps to ensure that the correct problem is addressed.

Critical and Creative Thinking By Design

Solution Space

During the ideate phase, designers generate as many ideas for potential solutions as they can. Outlandish and even improbable ideas are all welcome at this point, because as we offer ideas without judgment then even more ideas follow. No idea is a bad one as designers build a list of possible solutions, and the more ideas one can generate the more creative and useful the potential for the outcome. A simple way to get started ideating is to finish the phrase "what if we…" with as many answers as possible.

During the prototype and test phase, designers build physical models of their ideas in a raw, unpolished form. They then present their prototypes to a public audience to get feedback that informs successive iterations of the ultimate solution. Prototyping and testing helps to illuminate the flaws in a design before too much energy and time is invested in it. The designer who uses an iterative process to improve the final outcome is much more likely to deliver a pragmatic and valuable product.

Through successive iterations of these phases of design, a designer will ultimately determine that his or her product satisfactorily addresses the problem. Feedback during the testing phase confirms that the target audience will find value in the product, so the problem is solved and the product is ready for launch.

Mapping Critical and Creative Thinking to Design

		Idea Generation	Self Regulation	Reflective Judgment	Attitudes and Dispositions
Narrow the Focus	Conceptualize; observe; infer; recognize a challenge; analyze; interpret; hypothesize; demonstrate autonomy; recognize relevance	■	■	■	■
Empathize	Examine ideas in new ways; observe; infer; extrapolate; assess knowledge; recognize a challenge; question; separate; judge value; judge worth; avoid impulsivity; reject stereotypes and prejudices; embrace multiple viewpoints; judge assumptions; remain sensitive and open-minded	■	■	■	■
Define	Analogical thinking; metaphorical thinking; elaborate; infer; extrapolate; recognize a challenge; assess knowledge; understand ability; separate; relate; organize; interpret; summarize; judge resources; judge logic; avoid impulsivity; reject stereotypes and prejudices; judge assumptions	■	■	■	■
Ideate	Brainstorm; remote association; analogical thinking; metaphorical thinking; understand ability; allocate resources; identify consequences; hypothesize; embrace multiple viewpoints; tolerate ambiguity	■	■	■	■
Prototype and Test	Conceptualize; explore; allocate resources; revise; compose; persist; take risks; exhibit courage of conviction; identify worth/applicability of ideas; confidence	■	■	■	■
Launch	Understand one's ability, evaluate process and product; judge value and worth; take risks		■	■	

Additional Resources

We are grateful to the Hasso Plattner Institute of Design at Stanford (d.school) for a plethora of resources that they share online for free. Find them on the web at dschool.stanford.edu

We also derive much inspiration from the online resources offered by IDEO, a global design consultancy with a significant branch focused on education. Find them on the web at http://www.ideo.com/expertise/education

For additional information about the IDEA Studio team, our research, and our current and past projects, visit us on the web at http://www.icat.vt.edu/IDEAS/index.html

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