Building Adaptive Capacity Through Low-Stakes Creative Mini-Tasks: A Mixed-Methods Study of Creative Self-Efficacy, Risk-Taking, and Persistence

Susan Sobehrad

Central Michigan University

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Abstract

With the increasing integration of artificial intelligence into the workforce, preparing students to adapt to uncertainty and solve ill-structured problems has become an essential goal of education. Analysis of the PISA 2022 Creative Thinking Assessment indicates that students' creative self-efficacy is influenced by teachers' ability to establish classroom ecosystems that support adaptive thinking through autonomy, productive risk-taking, normalization of failure, and opportunities for creative choice.

Building on these observations, this mixed-methods study examined whether repeated participation in content-related, low-stakes multimodal creative mini-tasks strengthened students' adaptive capacity. Thirty-four eighth-grade students participated in three creative challenges during a nine-week intervention. Pre- and post-intervention surveys, classroom observations, and analyses of student discourse were used to examine creative self-efficacy, creative personality, creative habits of mind, divergent thinking, and engagement with ill-structured problem solving.

Although average scores changed only modestly, post-intervention analyses demonstrated stronger integration among creative self-efficacy, creative habits of mind, and creative personality. Crosstab analyses indicated that the relationship between creative habits of mind and creative personality remained significant from pretest ($p = .034$) to posttest ($p = .015$), while the relationship between creative habits of mind and creative self-efficacy strengthened from nonsignificant ($p = .33$) to significant ($p = .010$). Regression analyses further showed that creative habits of mind emerged as a significant predictor of creative self-efficacy following the intervention. Classroom observations and student discourse complemented these results by demonstrating increased evidence of flexible thinking, collaboration, curiosity, and iterative problem solving.

The results support the conclusion that repeated, low-stakes creative experiences strengthen adaptive capacity by integrating students' creative confidence, dispositions, and problem-solving behaviors. They further indicate that psychologically safe classroom ecosystems emphasizing student choice, productive failure, and reflection may help prepare learners for increasingly complex, technology-rich environments.

Keywords: creative habits of mind, creativity, affordances, creative self-efficacy

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Introduction

Young children naturally engage in imaginative play, experimentation, and storytelling. Yet over time, many students begin to view learning as the search for a single correct answer. As Liu and Noppe-Brandon (2009) observed, students become “contaminated” by the belief that every question has only one right answer (p. 188). This mindset can increase the fear of failure which diminishes curiosity and discourages risk-taking, reducing students’ willingness to explore alternative possibilities. As a result, students may become less prepared to navigate uncertainty.

The Research Problem

The purpose of this study was to investigate whether participation in low-stakes creative mini-tasks could strengthen students' adaptive capacity and their ability to navigate uncertainty by enhancing creative self-efficacy, creative habits of mind, and willingness to engage in ill-structured problem solving. Adaptive capacity is conceptualized as students' confidence in generating ideas, persisting through uncertainty, taking intellectual risks, and adapting their thinking when faced with unfamiliar challenges.

Justification for Research

The importance of creativity in education is well established (Beghetto, 2016; Beghetto & Kaufman, 2010, 2014; Guilford, 1967; Kettler et al., 2018; Robinson, 2011; Rubenstein et al., 2018). Creativity enhances student engagement, self-expression, and responsiveness to diverse learning needs (Katz‐Buonincontro et al., 2020). At the same time, scholars continue to express concern that creativity is declining as schools face increasing pressure from standardized testing

and highly structured curricula (Bereczki et al., 2018; Harris & de Bruin, 2017; Henriksen et al., 2021; Hopkins, 2019; Mullet et al., 2016). This lack of creative opportunity in the classroom contributes to what some research has identified as a creativity gap between the creativity shown by students while they are at school compared to creativity shown by students while out of school (Runco et al., 2017). Whether the gap is related to the increased structure and focus of schools on standardized testing or to a teacher's misunderstanding of the creative process, beliefs of employers and teachers about the value of creativity are clear: creativity is essential and should be developed throughout systems of education.

A common misconception that exacerbates the lack of creative opportunity is that creativity requires extensive projects or artistic products that compete with instructional time. However, creativity is often domain-specific and can be embedded within existing content learning. When students possess sufficient domain knowledge, creative activities can deepen understanding and improve learning outcomes. Moreover, creativity remains one of the most highly valued skills in a rapidly changing workforce where adaptability, innovation, and problem solving are increasingly essential.

Conner et al. (2018) state that engaging in creative activities regularly can promote positive psychological functioning. From a self-determination perspective, these experiences may strengthen students' confidence and willingness to persist through challenges. Such dispositions are increasingly important as learners prepare to navigate complex and uncertain future environments.

Deficiencies in the Literature

Although educators generally value creativity, many continue to equate creativity with the production of novel products rather than the development of creative processes (Glăveanu &

Beghetto, 2021; Vincent-Lancrin et al., 2019). This perspective often leads teachers to view creativity as time-intensive and difficult to integrate into standards-based instruction.

As a result, practical strategies for fostering everyday creativity in classrooms remain limited. While research proposes that frequent creative engagement can enhance creative confidence and motivation, there is little empirical evidence examining whether brief, low-stakes creative experiences can strengthen students' creative self-efficacy, creative habits of mind, and readiness to engage in more complex problem solving.

This study addresses that gap by investigating whether repeated participation in simple creative challenges can strengthen adaptive capacity through improvements in creative self-efficacy, creative habits of mind, and creative identity.

Significance of the Study

Glăveanu's (2012) affordance model of creativity emphasizes the discovery of previously unseen possibilities. In educational settings, this requires opportunities for students to explore unconventional uses of materials, generate multiple solutions, and engage in imaginative thinking (Withagen & van der Kamp, 2018). Such experiences have been associated with enhanced creativity and improved learning outcomes (Malau, 2020; Suardana et al., 2019).

As schools seek to prepare students for increasingly uncertain futures, understanding how simple, scalable classroom practices can cultivate adaptive capacity is of growing importance. Findings from this study may inform educators, instructional coaches, curriculum leaders, and policymakers seeking practical approaches to fostering creativity, resilience, and flexible problem solving within everyday instruction.

Literature Review

Student Perceptions of Creativity and Adaptive Capacity

Creative self-efficacy—the belief that one can generate effective solutions to challenging problems—is an important component of adaptive capacity (Beghetto & Karwowski, 2017). Although many students report confidence in everyday creativity, they are less confident when creativity is required in academic settings (OECD, 2024). Students who doubt their creative abilities may be less willing to engage with uncertainty, persist through challenges, or generate alternative solutions.

One factor contributing to low creative self-efficacy is the persistent belief that creativity is an innate talent possessed only by exceptionally gifted or artistic individuals (Cronin & Loewenstein, 2018; Glăveanu, 2014; Runco, 2007). This "art bias" can limit students' perceptions of their own creative potential and reduce their willingness to approach problems in novel ways. Encouragingly, students generally believe creativity can be learned when classroom conditions support exploration and risk-taking (Beghetto & Kaufman, 2014; OECD, 2024).

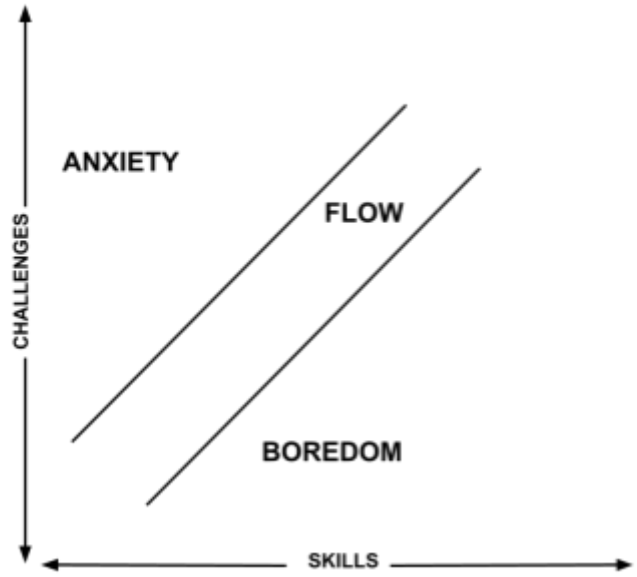
Fear of failure presents an additional barrier to adaptive capacity. Educational systems that emphasize standardization and performance metrics often position failure as something to be avoided rather than a necessary part of learning (Creely et al., 2018; Rich, 1991). According to Bandura (1977), repeated experiences of failure can diminish self-efficacy and increase avoidance behaviors. In contrast, low-stakes environments that normalize experimentation and reduce the consequences of failure can strengthen self-efficacy and encourage intellectual risk-taking (Bandura, 1977; Zuo et al., 2021). Providing students with autonomy, opportunities for choice, and support for creative risk-taking can therefore enhance both creativity and the adaptive capacity needed to navigate uncertainty (Harris & de Bruin, 2018; Ryan & Deci, 2000).

Creative Mindset and Adaptive Capacity

Adaptive capacity depends in part on a creative mindset characterized by openness, curiosity, and a willingness to engage with new experiences. Individuals high in openness are more likely to tolerate ambiguity, explore unfamiliar situations, and consider multiple perspectives—qualities associated with both creativity and adaptation (Abu Raya et al., 2023; McCrae & Costa, 1997; Puryear et al., 2017).

Curiosity further supports adaptive capacity by motivating individuals to seek information, resolve uncertainty, and persist in learning (Kashdan et al., 2018). Curiosity and grit have both been identified as predictors of creative achievement (Lin et al., 2024). When students encounter manageable uncertainty, they become more comfortable navigating ambiguity, a critical skill in complex and ill-structured problem spaces (Jirout et al., 2018; Tan et al., 2019). Flow may serve as a mechanism linking curiosity, creativity, and adaptation. According to Csikszentmihalyi (2014), flow occurs when individuals become deeply engaged in meaningful activity. Students who experience flow are more likely to persist through challenges and sustain attention while solving complex problems. Research supports the idea that curiosity contributes to flow, which in turn enhances creativity (Schutte & Malouf, 2020).

Figure 1 *Creative Flow (Csikszentmihalyi, 2007).*



Creative Habits of Mind as Affordances for Adaptive Capacity

This study views creative habits of mind as affordances that support adaptive capacity. Affordances emerge through interactions between individuals and their environments and enable purposeful action (Cong-Lem, 2022; Vyas et al., 2006). When practiced regularly, creative habits of mind become cognitive tools that help individuals respond effectively to novel situations.

Sternberg (2007) argues that creativity is a habit that develops through repeated opportunities to question assumptions, redefine problems, and tolerate ambiguity. Habits such as perceiving, patterning, abstracting, modeling, play, and synthesizing enable learners to recognize change, generate alternatives, evaluate possibilities, and adapt their thinking when faced with uncertainty (Mishra et al., 2011).

Table 1 *Creative Habits of Mind as Affordances (Inspired by Mishra et al., 2011)*

HABIT OF MIND	CONNECTION TO CREATIVITY	AFFORDANCE
Perceiving	● Curious inquiry and question-asking ● Imagery involves sensory information	Improved perceptions allow individuals to respond to changes in environment
Patterning	● Dissecting components of patterns ● Manipulation of observed components to constructing new patterns	The ability to see patterns and trends is a crucial skill when making predictions about the effects of change
Abstracting	● Separation of essential/nonessential data ● Connecting disparate things/idas ● Divergent thinking	Abstract thinking allows individuals to imagine many different solutions to solving ill structured problems
Embodied Thinking	● Imagining abstractions by thinking/feeling ● Empathizing with alternative perspectives ● Cooperating with others during ideation	Embodiment can open pathways to more diverse and equitable solutions to problems
Modeling	● Dimensional scaling ● Dimensional viewing (e.g., 2-D vs 3-D) ● Multiple iterations based on trial and reflection	Designing solutions is made possible by the ability to envision new ways of making and doing
Play	● Transformation of one thing to another ● Open-ended exploration ● Perfecting alternative methods of doing	Original solutions arise from unexpected combinations of thoughts, ideas, or materials
Synthesizing	● Integrating feedback to improve outcomes ● Recombination of observed and experiential data into new knowledge	New paradigms result from the recombination of old parts

Similarly, process-oriented approaches to creativity emphasize the development of flexible thinking rather than the production of creative products (Glăveanu & Beghetto, 2021). Rubrics that assess fluency, flexibility, originality, and elaboration encourage students to practice the thinking processes that underlie both creativity and adaptive capacity (Shively et al., 2018).

Table 2 *Creative Thinking Process Rubric (Shively et al., 2018)*

	Novice	Developing	Expert
Fluency	Students considered one idea.	Students considered several ideas.	Students considered many ideas.
Flexibility	Students considered one type of idea.	Students considered several types of ideas.	Students considered many types of ideas.
Originality	Students developed a common idea that many other students would have suggested and/or replicated an existing idea.	Students developed an interesting idea that several other students would have suggested and/or minimally added onto an existing idea.	Students developed a unique idea that few other students suggested and/or substantially built upon an existing idea in a unique way.
Elaboration	Students added minimal details and improvements to their ideas.	Students added a few details and improvements to their ideas.	Students added many significant details and improvements to their ideas.
Usefulness	Students proposed ideas that may meet the end user's needs in certain conditions.	Students proposed ideas that would meet the end-user's needs.	Students proposed ideas that would meet the end-user's needs and significantly add value to their lives.
Creative Strategy	Students randomly selected and implemented a creative thinking strategy, and/or they were unable to leverage the strategy to improve their ideas.	Students selected and implemented a creative thinking strategy to develop their ideas. They explained how the strategy supported their creativity.	Students deliberately selected and implemented a creative thinking strategy to develop their ideas. They explained how the strategy supported their creativity.

Creative Classroom Culture

Classroom culture plays a critical role in developing adaptive capacity. Policies emphasizing standardization, accountability, and high-stakes testing often reduce opportunities for exploration, curiosity, and creative risk-taking (Au, 2007; Rubenstein et al., 2018; Zhao & Gearin, 2016). Such environments may discourage students from questioning assumptions, exploring alternatives, and developing the flexibility needed to respond to changing circumstances.

In contrast, classrooms that provide autonomy, relevance, collaboration, and opportunities for creative exploration help students develop the confidence and habits necessary to adapt to unfamiliar challenges (Beghetto & Kaufman, 2014). By embedding creative experiences into everyday learning, teachers can cultivate classroom ecosystems that support both creativity and adaptive capacity.

Research Questions

1. How does participation in small creative challenges influence students' perceptions of their adaptive capacity as reflected in creative self-efficacy?
2. How does participation in small creative challenges influence students' perceptions of their adaptive capacity as reflected in creative personality traits?
3. How does participation in small creative challenges influence students' perceptions of their adaptive capacity as reflected in creative habits of mind?

Research Methods

Introduction

As routine tasks become increasingly automated, human success will depend on the ability to adapt to new technologies and ways of working. Skills such as creative thinking, critical thinking, and mental flexibility are less susceptible to automation and enable individuals to augment machine-based processes in complex and uncertain environments (Dondi et al., 2021; Vincent-Lancrin et al., 2019). Developing students' adaptive capacity—the ability to respond effectively to novel situations, ambiguity, and ill-structured problems—therefore requires intentional opportunities to practice creative thinking in the classroom.

Sample and Procedure

Sample

Participants were selected through convenience sampling and included all eighth-grade students enrolled in an elective project-based course during two quarters at a public middle school in Michigan. Enrollment was based on student choice and counselor placement. Of the 35 students enrolled, 34 elected to participate.

Research Procedure

The study took place in an eighth-grade project-based learning course where students worked independently or collaboratively to solve ill-structured problems. During each nine-week quarter, students completed three brief creative challenges administered at the beginning, midpoint, and end of the term. The challenges were designed to engage creative habits of mind associated with adaptive capacity, including problem framing, perspective-taking, collaboration, experimentation, and flexible thinking (Table 3).

Table 3 *Ill-Structured Tasks*

Title	Instructions	Materials Provided
Task One: Build a Better Bug	Work with a partner or small group of 3-4 people. Using the supplies you are given, create a new species of bug. Take a picture and make a quick slide to introduce the name of your new species and their characteristics. You have 30 minutes to complete the task. Your time starts now!	1 plastic spoon 1 8” x 8” piece of aluminum foil Scissors Marker 3 cotton swabs 2 toothpicks 2 narrow popsicle sticks 1 clothespin 3 googly eyes 3 plastic beads 1 5” x 5” piece of paper 1 5” x 5” piece of corrugated cardboard 1 rubber band iPad w/Internet access Program for creating presentations
Task Two: Sticky Spaghetti Skyscrapers	Work with a partner or small group of 3-4 people. Construct the tallest skyscraper using spaghetti and marshmallows. You have 25 minutes to build. The tallest tower standing wins. Your time starts now!	5 large marshmallows 20 small marshmallows 50 pieces of spaghetti
Task Three: Storytelling	Work with a partner or small group of 3-4 people. Construct a story using at least 6 photos from the folder of images provided. You must use digital tools/programs so others can read your story as a book or play it as a video or song. You have 30 minutes to complete the task. Your time starts now!	iPad w/Internet access Shared folder containing 50 random travel images Programs for creating presentations/audio/video products

Three sources of data were collected. First, students completed pre- and post-intervention surveys measuring three dimensions of adaptive capacity: creative self-efficacy, creative personality, and creative habits of mind. Second, non-participatory classroom observations were conducted using a Likert-scale observation tool aligned to creative habits of mind. Third, audio recordings of student group discussions during problem-solving activities were analyzed for evidence of creative thinking and adaptive responses to uncertainty over time.

Instrumentation

The survey instrument combined adapted items from validated measures with original items developed by the researcher. Minor wording changes were made to ensure appropriateness for eighth-grade students.

Creative Self-Efficacy

Part I measured students' perceptions of their creative self-efficacy using items adapted from the Short Scale of Creative Self (Karwowski et al., 2018). Creative self-efficacy was included because confidence in one's ability to generate solutions to unfamiliar problems is a key component of adaptive capacity. Only items related to creative self-efficacy were included. The original scale reported reliability coefficients of approximately .80 (Karwowski et al., 2018).

Creative Personality

Part II measured students' perceptions of their creative personality using selected items from the Big Five Inventory-10 (BFI-10) (Rammstedt & John, 2007) and the Five-Dimensional Curiosity Scale (Kashdan et al., 2020). Items representing openness, extraversion, joyous exploration, and thrill seeking were selected because they are associated with curiosity, flexibility, and willingness to engage with uncertainty which are all characteristics that contribute to adaptive capacity. The BFI-10 retains approximately 85% of the reliability of the original

instrument (Rammstedt & John, 2006), while the curiosity scale demonstrated reliability coefficients ranging from .70 to .90 (Kashdan et al., 2020).

Creative Habits of Mind

Part III consisted of researcher-developed items designed to measure students' perceptions of their creative habits of mind. These items were based on Sternberg's (2007) view of creativity as a habit and aligned with Mishra et al. 's (2011) seven transdisciplinary creative habits of mind (Table 1). Because these habits support flexible thinking, problem solving, persistence, and adaptation, they were viewed as behavioral indicators of adaptive capacity.

Divergent Association Task (DAT)

To provide an additional measure of creative thinking, students completed a Divergent Association Task (DAT). Students generated ten unrelated nouns, and semantic distance among the words was calculated using a digital scoring tool based on the GloVe algorithm (Olson et al., 2021; Pennington et al., 2017). Greater semantic distance indicates stronger divergent thinking, a construct associated with both creativity and the ability to generate alternative responses when confronted with novel situations (Said-Metwaly et al., 2024). Typical DAT scores range from 65 to 90, with higher scores reflecting greater divergent thinking ability (Olson et al., 2021).

Because data were collected across two quarters within the same classroom and under the supervision of the same teacher, the study provided an opportunity to examine the reliability and validity of the composite survey instrument, including the researcher-developed items. In combination, the measures were intended to assess changes in students' adaptive capacity through shifts in creative self-efficacy, creative personality, and creative habits of mind.

1. Quantitative Analysis

This study examined the potential of brief, low-stakes creative challenges to strengthen students' adaptive capacity in a middle school classroom. Adaptive capacity was conceptualized as students' ability to respond effectively to novel, uncertain, and ill-structured situations through three interconnected dimensions: creative self-efficacy, creative personality, and creative habits of mind. An additional measure of divergent thinking was included using the Divergent Association Task (DAT). Pre- and post-intervention surveys were administered to determine whether participation in the creative challenges influenced students' perceptions of these dimensions of adaptive capacity and their divergent thinking performance.

1.1 Descriptive Statistics

1.1.1 Creative Self-Efficacy

How does participation in small creative challenges influence students' perceptions of their adaptive capacity as reflected in creative self-efficacy? To answer this question, the researcher designed eight items to be used in both the pre- and post-intervention survey. The questions and results are listed in Table 4.

Table 4 *Students' Perceptions of Their Creative Self-Efficacy*

Survey Item	Pre-Intervention Agree (%)	Post-Intervention Agree (%)	Change
1. I think I am a creative person.	**100.0**	**100.0**	0.0
2. Being creative is an important part of myself.	82.4	82.3	-0.1
3. I know I can solve complicated problems.	70.6	76.4	**+5.8**
4. I trust my creative abilities.	76.5	79.4	+2.9
5. My imagination and originality distinguish me from my friends.	56.9	58.8	+1.9
6. Many times I have proven that I can handle difficult situations.	79.4	85.3	**+5.9**
7. I am sure I can deal with problems requiring creative thinking.	82.3	85.3	+3.0

8. I am good at proposing original solutions to problems.	58.8	73.6	**+14.8**

Note. *Agree = "Definitely Yes" + "Somewhat Yes." Percentages may not = 100% due to rounding. Adapted from the Short Scale of Creative Self with selections from Karwowski et al., 2018.*

Students entered the study with relatively high perceptions of their creative self-efficacy, leaving limited opportunity for large gains. Nevertheless, positive shifts were observed on six of the eight survey items following participation in the creative challenges. The greatest improvement occurred for "I am good at proposing original solutions to problems," which increased by 14.8 percentage points (58.8% to 73.6%). Notable gains also occurred in students' confidence that they could handle difficult situations (+5.9%) and solve complicated problems (+5.8%).

Smaller improvements were observed in students' confidence in their creative abilities (+2.9%), their ability to solve problems requiring creative thinking (+3.0%), and the originality of their imagination (+1.9%). Perceptions of being a creative person remained universally high before and after the intervention (100%), while viewing creativity as an important part of one's identity remained essentially unchanged (82.4% to 82.3%).

These comparisons show that the intervention had a greater influence on students' confidence in using creativity to respond to challenges than on broader beliefs about their creative identity. Rather than changing how students viewed themselves as creative individuals, the creative challenges appeared to strengthen their confidence in applying creativity to solve unfamiliar problems and navigate difficult situations.

1.1.2 Creative Personality

How does participation in small creative challenges influence students’ perceptions of their adaptive capacity as reflected in creative personality traits? To answer this question, the

researcher included 15 items related to personality traits on the pre- and post-intervention survey. The questions and results are listed in Table 5.

Table 5 *Students' Perceptions of Their Creative Personality*

Survey Item	Pre-Intervention Agree (%)	Post-Intervention Agree (%)	Change
9. I view challenging situations as an opportunity to grow and learn.	**50.0**	**47.1**	-2.9
10. I look for experiences that challenge how I think.	47.0	50.0	+3.0
11. I seek situations requiring deep thinking.	35.3	47.1	**+11.8**
12. I enjoy learning about unfamiliar subjects.	35.3	44.1	+8.8
13. I find it fascinating to learn new information.	55.8	64.7	+8.9
14. Thinking about difficult problems keeps me awake at night.	47.1	47.1	0.0
15. I can spend hours on a problem because I want to know the answer.	47.0	64.7	**+17.7**
16. I work harder when I cannot immediately solve a problem.	47.0	41.2	-5.8
17. I keep working on important problems even when they are hard.	41.2	55.9	**+14.7**
18. I see myself as someone who has many artistic interests.	44.3	47.1	+2.8
19. I see myself as outgoing and sociable.	44.1	47.1	+3.0
20. I see myself as relaxed and able to handle stress well.	38.2	44.1	+5.9
21. I see myself as someone who is active and imaginative.	64.7	61.8	-2.9
22. I see myself as someone who does not get nervous easily.	29.4	50.0	**+20.6**
23. Creativity is an important part of myself.	44.1	58.8	**+14.7**

Note. *Agree = "Completely Describes Me" + "Mostly Describes Me." Percentages may not total exactly 100% because of rounding. Adapted from the Big Five Inventory-10 short Form, Rammstedt & John, 2007, and the Five Dimension Curiosity Scale, Kashdan et al., 2018.*

Students' perceptions of their creative personality generally became more positive following participation in the creative challenges. Improvements were most evident in characteristics associated with openness, persistence, curiosity, and resilience, all of which contribute to adaptive capacity.

The largest gain occurred in students' perception that they do not get nervous easily (+20.6%), followed by their willingness to persist on difficult problems (+17.7%) and continue working on important problems even when they are challenging (+14.7%). Students also reported a substantial increase in viewing creativity as an important part of themselves (+14.7%). Moderate gains were observed in seeking intellectually challenging situations (+11.8%), learning about unfamiliar subjects (+8.8%), fascination with new information (+8.9%), and handling stress (+5.9%).

Several items showed little or no change. Thinking about difficult problems remained unchanged, while slight decreases were observed in viewing challenges as opportunities for growth (-2.9%), working harder after becoming frustrated (-5.8%), and identifying as active and imaginative (-2.9%). These small decreases were offset by stronger gains in persistence, curiosity, and resilience, indicating that students' perceptions shifted toward seeing themselves as individuals who continue working through difficult and uncertain situations rather than relying solely on innate traits.

The pattern indicates that the intervention influenced personality characteristics most closely associated with adapting to unfamiliar challenges rather than broad personality dispositions.

1.1.3 Creative Habits of Mind

How does participation in small creative challenges influence students' perceptions of their adaptive capacity as reflected in creative habits of mind? To answer this question, the researcher included 11 items on the pre- and post-intervention survey. The questions and results are listed in Table 6.

Table 6 *Students' Perceptions of Their Creative Habits of Mind*

Survey Item	**Pre Agree (%)**	**Post Agree (%)**	**Change**
24. I understand what I need to do to accomplish a task.	**76.5**	**70.6**	-5.9
25. I think of multiple ways to complete a task before settling on one idea.	70.6	79.4	**+8.8**
26. I think of more than one way to rearrange resources to complete a task.	73.5	88.2	**+14.7**
27. I share ideas and work with teammates to find the best solution.	76.5	70.6	-5.9
28. I sketch a picture or use materials to make a plan before completing a task.	58.8	58.9	+0.1
29. I experiment with materials and discover ways to complete a task without making a plan.	58.8	82.3	**+23.5**
30. If a plan is unsuccessful, I think about what went wrong before trying something new.	64.7	61.8	-2.9
31. I often come up with new ideas while working on a project.	73.5	85.3	**+11.8**
32. I combine several ideas together to complete a task.	70.6	70.6	0.0
33. I enjoy sharing my ideas with others to get feedback.	73.5	79.4	+5.9

34. Working with other people helps me come up with creative solutions.	70.6	70.6	0.0

***Note**. Agree = Strongly Agree + Agree a Little. Percentages may not = 100% due to rounding. Original questions inspired by the seven trans-disciplinary habits of mind from Mishra et al., 2011)*

Students' perceptions of their creative habits of mind demonstrated a mixed but generally positive pattern following participation in the creative challenges. The largest increases occurred in behaviors associated with flexibility, experimentation, and idea generation. The greatest improvement was observed for experimenting with materials and discovering solutions without first making a plan, which increased by 23.5 percentage points (58.8% to 82.3%). Students also reported substantial gains in their ability to rearrange available resources to solve problems (+14.7%), generate new ideas while working on projects (+11.8%), and consider multiple approaches before selecting a solution (+8.8%).

More modest gains were observed in students' willingness to share ideas to receive feedback (+5.9%), while perceptions of combining ideas and working collaboratively to generate creative solutions remained essentially unchanged. Two items showed small declines: students' confidence in understanding what was required to accomplish a task (-5.9%) and working with teammates to determine the best solution (-5.9%). Students also reported a slight decrease in reflecting on unsuccessful plans before trying a new approach (-2.9%).

These decreases may reflect a shift in students' approach to problem solving rather than a reduction in adaptive capacity. As students became more comfortable with open-ended tasks, they appeared to rely less on predetermined plans and more on experimentation, iteration, and exploration. This interpretation is supported by the substantial increases in behaviors associated with flexible thinking and creative exploration.

In summary, this data corroborates the hypothesis that participation in brief, low-stakes creative challenges contribute to the development of several dimensions of students' adaptive capacity. While students entered the study with generally positive perceptions of themselves, notable gains were observed in their confidence to generate original solutions, solve complex problems, persist through challenges, think flexibly, experiment with alternative approaches, and view creativity as an important part of who they are. The greatest improvements occurred in behaviors associated with flexibility, exploration, persistence, and creative problem solving rather than in broad perceptions of creative identity, validating the idea that repeated engagement with ill-structured tasks may strengthen students' confidence in applying creativity to unfamiliar situations. Although a few individual items remained stable or showed slight declines, the pattern of responses indicates movement toward greater willingness to adapt thinking, tolerate uncertainty, and respond creatively to complex challenges. These analyses support the proposition that regular opportunities to engage in authentic creative experiences can strengthen the knowledge, dispositions, and habits of mind that underpin adaptive capacity and prepare students to navigate increasingly complex and unpredictable learning and work environments.

1.2 Visual Comparison of Adaptive Capacity Measures

1.2.1 Pre-/Post- Scores by High and Low Creative Self Efficacy

Figure 2a

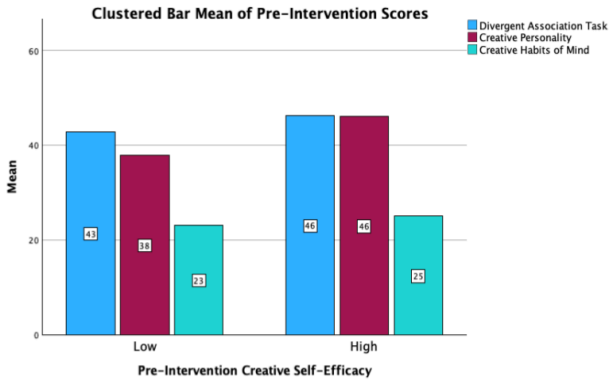
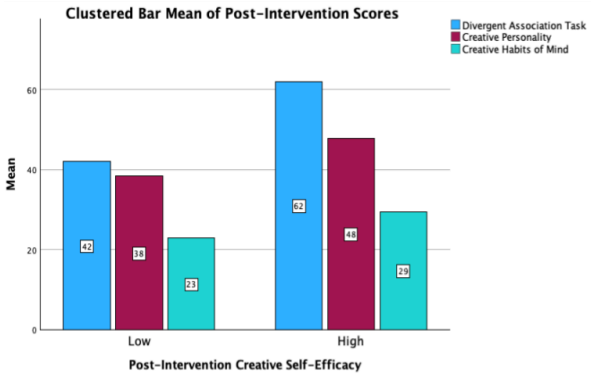


Figure 2b



Figures 2a and 2b provide a visual comparison of adaptive capacity measures for students reporting low and high creative self-efficacy. Students with higher creative self-efficacy consistently demonstrated higher scores in creative personality, creative habits of mind, and divergent thinking before the intervention. Following the intervention, these differences became more pronounced, particularly for divergent thinking. The figures show that students who entered the intervention with stronger creative confidence also demonstrated greater gains across several dimensions of adaptive capacity.

1.2.2 Pre- and Post-Divergent Association Task Scores

Figure 3

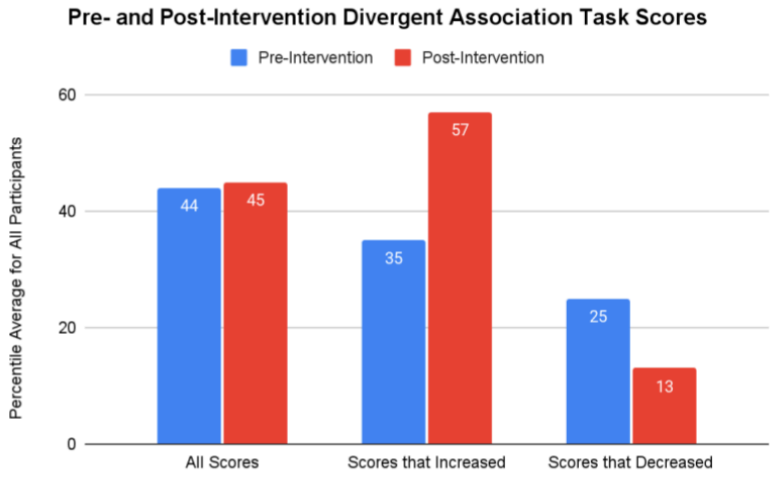


Figure 3 compares pre- and post-intervention Divergent Association Task (DAT) scores for all participants and for the subgroups whose scores either increased or decreased over the course of the intervention. Although the mean DAT score changed very little (44 to 45), individual student performance varied considerably. Students whose scores improved demonstrated a substantial increase, from a mean percentile score of 35 to 57, whereas students whose scores declined decreased from 25 to 13.

The minimal change in the mean reflects the offsetting effects of these two groups rather than a lack of individual growth. While some students demonstrated marked gains in divergent thinking, others experienced decreases, resulting in little change at the class level. Thus, divergent thinking may develop differently across students and may be influenced by individual differences in prior experiences, cognitive flexibility, or engagement with the creative challenges.

Importantly, this evidence helps explain an apparent contradiction in the study. Although students demonstrated stronger relationships among the self-perception measures of adaptive capacity—creative self-efficacy, creative personality, and creative habits of mind; the DAT average changed very little. Rather than indicating that the intervention was ineffective, the DAT results reveal that adaptive capacity is multidimensional and not fully captured by divergent thinking alone. While divergent thinking represents one aspect of creative cognition, the intervention appeared to have a more immediate influence on students' confidence, creative dispositions, and creative behaviors. Together, these observed relationships confirm the premise that adaptive capacity develops through the interaction of multiple cognitive and affective dimensions, with divergent thinking representing only one component of this broader construct.

1.3 Relationships Among the Dimensions of Adaptive Capacity

In addition to examining changes in individual measures of creative self-efficacy, creative personality, creative habits of mind, and divergent thinking, this study investigated whether the relationships among these constructs changed following participation in the creative challenges. Because adaptive capacity is conceptualized as the interaction of multiple dimensions rather than a single trait, chi-square tests of independence were conducted to examine associations between students' perceptions of their creative habits of mind and three related indicators: creative

self-efficacy, creative personality, and divergent thinking as measured by the Divergent Association Task (DAT).

Creative habits of mind served as the anchor variable because they represent the behavioral expression of adaptive capacity and were the primary focus of the intervention. Crosstab analyses were conducted using pre- and post-intervention data to determine whether participation in repeated, low-stakes creative challenges strengthened the relationships among these dimensions. Table 7 provides a summary of the chi-square analyses, followed by brief interpretations of each relationship.

1.3.1 Chi-Square Analyses

Table 7 *Summary of Chi-Square Analyses*

Variables	**Time**	**Pearson χ^2**	**p**	**Significant?**
CHOM × CSE	Pre	0.95	.329	No
CHOM × CSE	Post	6.60	.010	Yes
CHOM × Personality	Pre	4.48	.034	Yes
CHOM × Personality	Post	5.90	.015	Yes
CHOM × DAT	Pre	0.47	.492	No
CHOM × DAT	Post	1.11	.292	No

Note. *CHOM = Creative Habits of Mind; CSE = Creative Self-Efficacy; PER = Creative Personality; DAT = Divergent Association Task. Scores were dichotomized into* ***Low*** *and* ***High*** *categories using the median split for chi-square analyses. Pearson chi-square tests were used to examine associations between variables. Fisher's Exact Test and Yates continuity correction were consulted when appropriate because of the small sample size (N = 34). Pre refers to before the intervention, and Post refers to after the intervention.*

Creative Habits of Mind and Creative Self-Efficacy

Before the intervention, students' perceptions of their creative habits of mind were not significantly associated with creative self-efficacy ($\chi^2 = 0.95$, $p = .329$). Following the intervention, however, the relationship became statistically significant ($\chi^2 = 6.60$, $p = .010$). Students who reported stronger creative habits of mind were also more likely to report higher creative self-efficacy, indicating that repeated participation in the creative challenges strengthened the relationship between these two dimensions of adaptive capacity.

Creative Habits of Mind and Creative Personality

Students' perceptions of their creative habits of mind were significantly associated with creative personality before the intervention ($\chi^2 = 4.48$, $p = .034$), and this relationship became stronger following the intervention ($\chi^2 = 5.90$, $p = .015$). In short, students who viewed themselves as demonstrating stronger creative habits of mind also perceived themselves as more curious, persistent, and open to new experiences. The intervention appeared to reinforce this relationship.

Creative Habits of Mind and Divergent Thinking

No statistically significant relationship was found between students' perceptions of their creative habits of mind and Divergent Association Task (DAT) scores before ($\chi^2 = 0.47$, $p = .492$) or after ($\chi^2 = 1.11$, $p = .292$) the intervention. Although the relationship strengthened slightly following the intervention, students' self-perceptions of adaptive capacity were not closely associated with their divergent thinking performance as measured by the DAT.

Together, the chi-square analyses indicate that the intervention strengthened the relationships among students' self-perceptions of adaptive capacity. The most notable change occurred between creative habits of mind and creative self-efficacy, where a nonsignificant pre-intervention relationship became statistically significant following participation in the

creative challenges. Similarly, the significant relationship between creative habits of mind and creative personality became stronger after the intervention. In contrast, creative habits of mind were not significantly related to divergent thinking as measured by the DAT at either time point. Evidently, repeated engagement in low-stakes creative challenges primarily influenced students' perceptions of their adaptive capacity rather than their performance on a divergent thinking assessment.

1.3.2 Scatterplots

Figure 4a

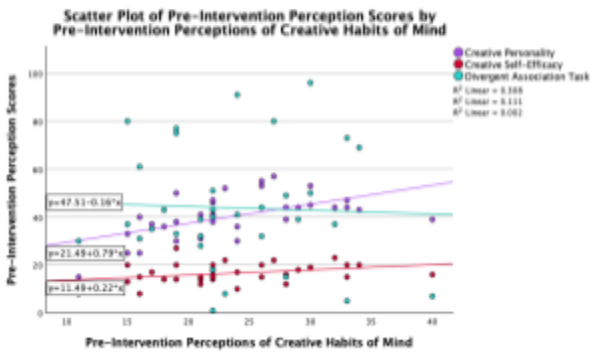
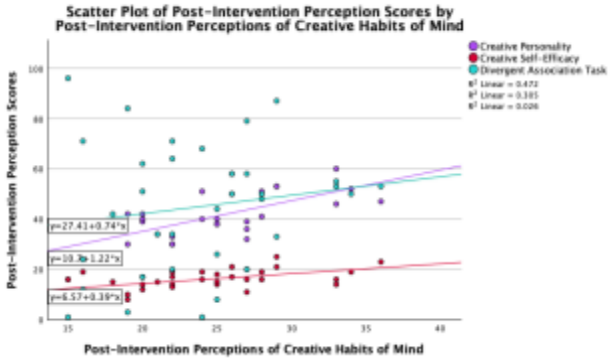


Figure 4b



Figures 4a and 4b illustrate the relationships between students' perceptions of creative habits of mind and the three indicators of adaptive capacity before and after the intervention. Prior to the intervention (Figure 4a), the strongest relationship was observed between creative habits of mind and creative personality (R^2 = .308), while a weaker positive relationship was found with creative self-efficacy (R^2 = .111). Little relationship was evident between creative habits of mind and Divergent Association Task (DAT) scores (R^2 = .002).

Following the intervention (Figure 4b), the relationships between creative habits of mind and both creative personality (R^2 = .472) and creative self-efficacy (R^2 = .305) became noticeably stronger. In contrast, the relationship between creative habits of mind and DAT scores remained weak (R^2 = .026). Visual inspection of the scatterplots therefore supports the chi-square analyses

and affirm that participation in the creative challenges strengthened the alignment among students' self-perceptions of creative habits of mind, creative personality, and creative self-efficacy, while having comparatively little effect on measured divergent thinking.

As a whole, the scatterplots provide visual evidence that the intervention strengthened the interconnected dimensions of adaptive capacity. Students' perceptions of their creative behaviors became more closely aligned with their confidence and creative dispositions following repeated engagement in low-stakes creative challenges, whereas divergent thinking, as measured by the DAT, remained relatively independent of these self-perceptions.

1.3.4 Pearson Correlations

Pearson correlation analyses were conducted to examine the relationships among the three self-perception measures representing adaptive capacity: creative self-efficacy, creative personality, and creative habits of mind. Correlations were calculated separately for the pre- and post-intervention surveys to determine whether the relationships among these dimensions changed following participation in the creative challenges.

Table 8 *Summary of Pearson Correlations*

Relationship	Pre-Intervention r	Post-Intervention r	Interpretation
CSE × Personality	.604	.488	Significant both
CHOM × Personality	.555	.687	Stronger post
CHOM × CSE	.333	.552	Emerged after intervention

Note. *CHOM = Creative Habits of Mind; CSE = Creative Self-Efficacy; PER = Creative Personality; DAT = Divergent Association Task.*

Prior to the intervention, creative personality demonstrated significant positive correlations with both creative self-efficacy ($r = .604$, $p < .001$) and creative habits of mind ($r = .555$, $p < .001$). However, the relationship between creative habits of mind and creative self-efficacy was not statistically significant ($r = .333$, $p = .054$). Thus, even though students' creative personality was already associated with both their confidence and their creative behaviors, their creative habits of mind were yet to become aligned with creative self-efficacy.

Following the intervention, all three dimensions of adaptive capacity were significantly correlated. Creative habits of mind demonstrated significant relationships with both creative self-efficacy ($r = .552$, $p < .001$) and creative personality ($r = .687$, $p < .001$), while the relationship between creative personality and creative self-efficacy remained significant ($r = .488$, $p = .003$). The emergence of a significant relationship between creative habits of mind and creative self-efficacy implies that repeated participation in the creative challenges strengthened the connection between students' creative behaviors and their confidence in their creative abilities.

1.3.5 Regression

Simple linear regression analyses were conducted to determine whether students' perceptions of their creative habits of mind predicted creative self-efficacy before and after the intervention.

Table 9 *Regression Summary Table*

Time	F	p	R^2	Interpretation
Pre-Intervention	3.99	.054	.111	Not significant
Post-Intervention	14.04	<.001	.305	Significant predictor

Before the intervention, creative habits of mind did not significantly predict creative self-efficacy. Following the intervention, however, creative habits of mind became a significant predictor, explaining approximately 31% of the variance in creative self-efficacy. As students increasingly perceived themselves engaging in creative habits of mind, they also gained confidence in their creative abilities, reinforcing the interconnected nature of adaptive capacity.

1.3.6 Changes in Adaptive Capacity Over Time

Paired-samples *t*-tests were conducted to determine whether students' scores on the four measures of adaptive capacity changed following participation in the creative challenges. Table 10 summarizes the pre- and post-intervention means, *t*-statistics, and significance levels for creative self-efficacy, creative personality, creative habits of mind, and Divergent Association Task (DAT) scores.

Table 10 *Paired-Samples t-Test Summary*

Measure	Pre-Intervention Mean	Post-Intervention Mean	t	p
Creative Self-Efficacy Scores	16.59	15.88	0.845	>.05
Creative Personality Scores	40.29	39.74	0.448	>.05
Creative Habits of Mind Scores	23.68	23.79	0.442	>.05
Divergent Association Task Scores	43.82	44.91	0.425	>.05

The paired-samples *t*-tests indicated that none of the four measures demonstrated statistically significant changes in mean scores from pre- to post-intervention. Although

descriptive analyses showed improvements on several individual survey items, these changes were not large enough to produce statistically significant differences in cumulative scale scores. This finding, consistent with the correlation and regression analyses, reinforces the inference that the intervention primarily strengthened the relationships among the dimensions of adaptive capacity rather than producing substantial changes in the mean scores.

2. Qualitative Analysis

The quantitative analyses indicated that repeated participation in low-stakes creative challenges strengthened the relationships among creative self-efficacy, creative personality, and creative habits of mind, leading to increased adaptive capacity. The purpose of the qualitative analyses was to examine how this adaptive capacity was expressed during authentic collaborative problem solving through classroom observations and examination of student discourse.

2.1 Classroom Observations of Adaptive Capacity

2.1.1 Observed Behaviors During Intervention

To better understand how adaptive capacity developed during the intervention, systematic classroom observations were conducted while students completed three collaborative creative challenges. Each group was observed using a structured rubric designed to capture two complementary dimensions of adaptive capacity. Creative process skills represented the observable behaviors students used during problem solving—including fluency, flexibility, originality, elaboration, and planning—while creative habits of mind reflected the cognitive dispositions guiding those behaviors, including curiosity, pattern recognition, abstraction, embodied thinking, modeling, play, and the application of prior knowledge.

Although these dimensions were analyzed separately, they functioned together during authentic problem solving. Creative process skills captured what students did, whereas creative habits of mind revealed how they approached complex, ill-structured challenges. Examining both dimensions provides a more comprehensive understanding of how adaptive capacity was enacted as students generated ideas, adapted their thinking, collaborated with peers, and refined solutions over time.

Table 11 *Observation Rubric Criteria and Results*

CREATIVE PROCESS Criteria	**Task 1: Inventing**	**Task 2: Engineering**	**Task 3: Technology**
Fluency: Students considered many ideas.	4	4	4
Flexibility: Students considered many types of ideas.	4	4	3
Originality: Students developed a unique idea that no one else thought of.	5	4	3
Elaboration: Significant details and many improvements were included.	4	4	3
Creative Strategy: Deliberate planning was observed.	2	2	3
CREATIVE HABITS OF MIND Criteria	**Task 1: Inventing**	**Task 2: Engineering**	**Task 3: Technology**
Curiosity: Individuals were curious and recognized new opportunities for change.	4	4	4
Patterns: Ability to see patterns and predict the effects of change was observed.	3	4	3
Abstractions: Abstract thinking allowed imaginative responses.	5	4	3

Embodied thinking: Empathetic responses were made to group members.	2	3	3
Modeling: Made sketches, models, or outlines before creating	2	2	2
Play: Play resulted in unexpected solutions.	4	4	3
Knowledge: Prior knowledge was recombined to create new ideas.	3	4	3

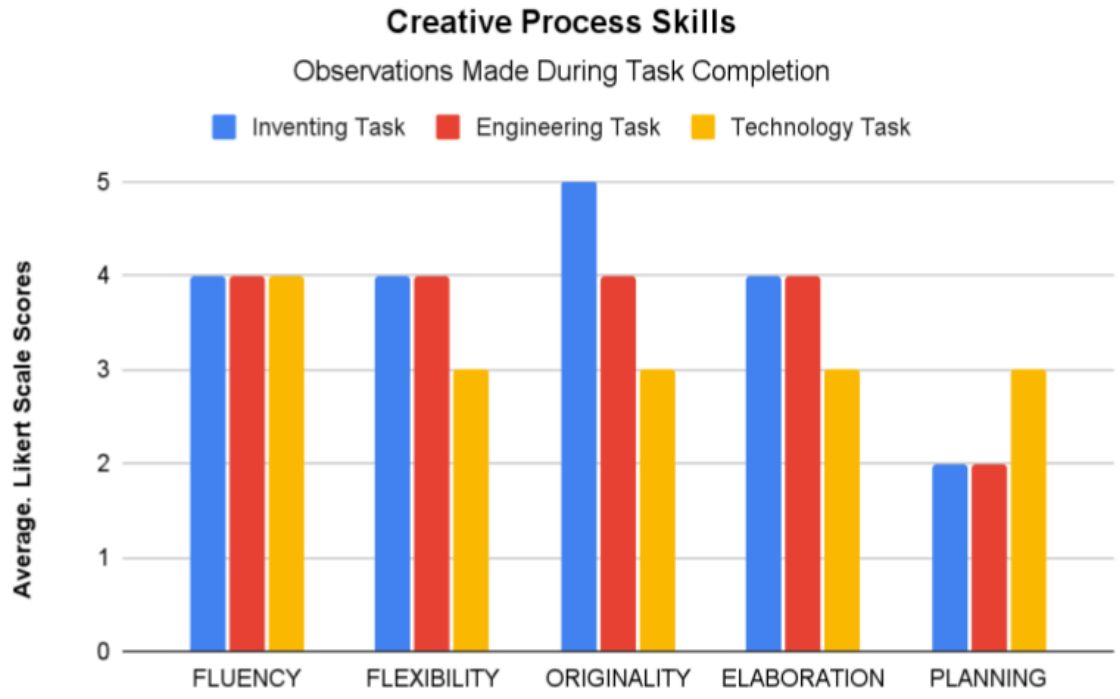
The classroom observation scores shown in Table 11 demonstrate that students consistently engaged in behaviors associated with adaptive capacity. Across all three tasks, students generated multiple ideas (fluency), explored alternative approaches (flexibility), developed original solutions, and elaborated on one another's ideas. At the same time, observations documented frequent use of creative habits of mind including curiosity, abstraction, pattern recognition, play, and application of prior knowledge. These observations are consistent with the belief that, during the interventions, adaptive capacity was enacted through both creative thinking and creative action during collaborative problem solving.

2.1.2 Creative Process Skills

Figure 5 summarizes the frequency of creative process skills observed as students completed the three collaborative creative challenges. These behaviors represent the observable actions through which students demonstrated adaptive capacity while generating ideas, exploring alternatives, refining solutions, and responding to ill-structured problems. Comparing the three

tasks provides insight into how different creative experiences elicited different aspects of the creative process.

Figure 5



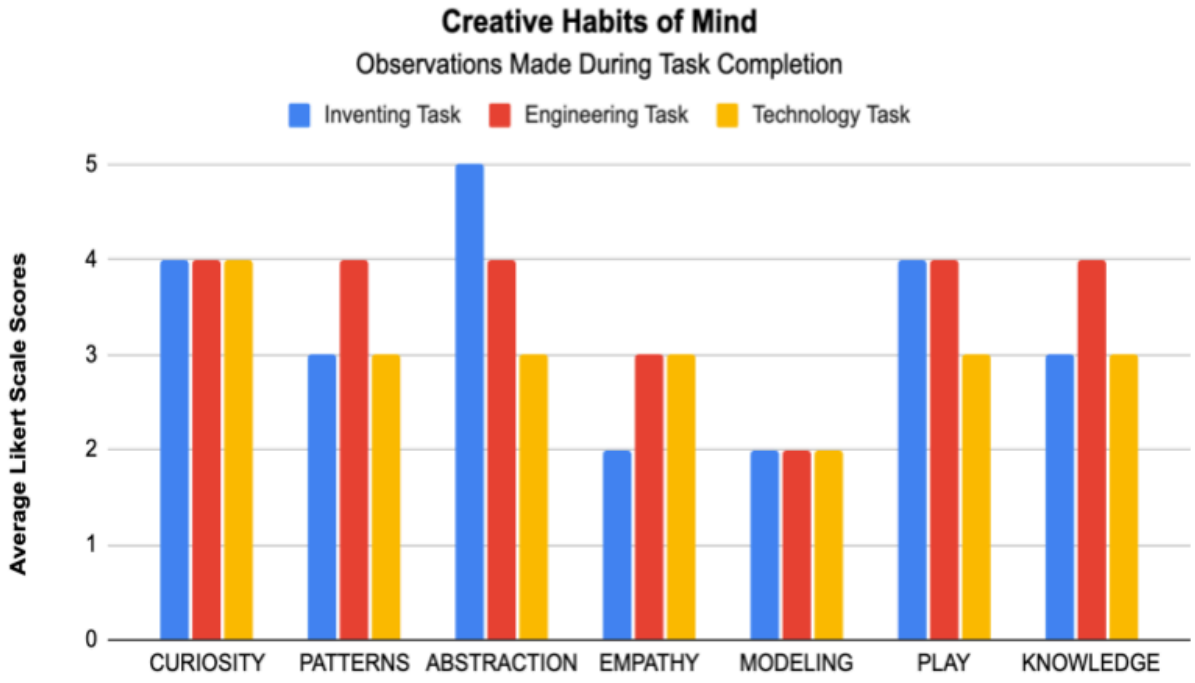
Inventing and engineering activities elicited consistently high levels of fluency, flexibility, originality, and elaboration, while the technology task required greater planning but somewhat lower levels of spontaneous idea generation. It appears that open-ended, hands-on design challenges more readily support the behavioral dimensions of adaptive capacity than technology-focused tasks.

2.1.3 Creative Habits of Mind

Figure 6 shows similar patterns for creative habits of mind. Curiosity remained consistently high across all three activities, while abstraction and playful experimentation were especially prominent during the inventing task. Engineering activities encouraged greater reliance on prior knowledge and pattern recognition, whereas technology tasks elicited comparatively fewer observable creative habits. According to these results, different types of

creative challenges activate different dimensions of adaptive capacity rather than a single uniform creative process.

Figure 6



2.1.4 Summary of Classroom Observations

Classroom observations indicate that adaptive capacity emerged through students' willingness to generate ideas, explore alternatives, draw upon prior knowledge, collaborate with peers, and refine solutions. Although each task emphasized different aspects of the creative process, all three provided opportunities for students to practice the interconnected thinking and behaviors associated with adaptive capacity.

2.2 Student Discourse

While classroom observations documented what students did, analyses of student conversations provided insight into how students thought as they navigated ill-structured problems.

Table 12 *Quotes Encompassing Words Related to Creative Habits of Mind*

Abstraction		
Word Choice	**Quotes**	**Rationale**
idea	"I have an idea If you stack the marshmallows it's perfect, it's moving. It's all about balance. . .	● New ideas require imagination and isolating a problem to solve. ● Brainstorming requires seeing multiple options for solving a problem.
or	"What if we make a hybrid? Or we can make it a chameleon We can wrap the string around it so that it can blend in with anything, because it's gray, and gray hides on rocks."	
Embodied Thinking		
Word Choice	**Quotes**	**Rationale**
can I	"Where can we use this? Can I just unfold this? Can we stick it in this? What? How many legs does it need? Four. No, two. Three."	Seeking approval from the team shows empathy for their points of view
should	"Should we try to connect the rubber band together with the toothpick?"	
want to	"Do you want to give it eyelashes, too?"	
Modeling		
Word Choice	**Quotes**	**Rationale**
try	"Basically, I'm going to try to break this into little tiny pieces so I can try to make a bigger base."	Trying out ideas to see if they work is modeling
work	"Would that work? No, wait, the tape doesn't stick to this. Oh, wait, paper. If we wrap it in paper, then it will stick."	
Patterns		
Word Choice	**Quotes**	**Rationale**
and then	"That's his body and then his neck, and then we can make his head out of this part of the spoon."	These words imply thinking about next steps, which is sequencing, a form of patterning
what about	"What about the toothpicks? We could probably just. . .We do have two toothpicks. We could just stab them through."	
what are	"What are you guys going to do? Let's make it like the, you know, the Space Needle in Seattle."	

Perceiving		
Word Choice	**Quotes**	**Rationale**
looks	"Hey, that kind of looks like the Eiffel Tower, if it was wobbly and made out of spaghetti."	● Imagery involves envisioning new possibilities ● Asking why suggests curiosity and a desire to know
what is	"What is this? It's like the tongue that holds the meat. Yeah, and when it moves, it snaps. Wait, can this be the meat? And then we put cardboard on the other end to make it look like a bear trap."	
why	"What does he eat? Dumpster food. Because he goes into trash cans. He eats drawings. . .Is that why he's called the Doodlebug? Yes. He eats people's drawings."	
Play		
Word Choice	**Quotes**	**Rationale**
about	"What if we take these? Put them in just here. And then put another marshmallow here. Believe in my marshmallow skills, okay?"	Coming up with unusual ideas and using humor are ways to play with ideas
could	"You think I might put this little paper clip in the back? It could be used as, like a whip. . .it's a tail whip. It looks like that, and it's kind of cute."	
if	"What is this supposed to mean? If saltwater snails exist, they're very much going to be turned into escargots."	
Synthesizing		
Word Choice	**Quotes**	**Rationale**
good	"Guys, is this good? We don't have to use all the resources, but let's use as much as possible so it looks really fun. Is this good?"	Evaluation means envisioning how components fit into the completed product
make	"I think we just need to make this a little more secure and stable or something."	

Table 12 provides representative excerpts from student conversations illustrating how creative habits of mind emerged during collaborative problem solving. Rather than evaluating the quality of students' final products, the analysis focused on the thinking processes revealed through students' language as they responded to open-ended, ill-structured challenges. Word choices were interpreted within the context of the conversations to identify evidence of the cognitive and social processes that characterize adaptive capacity.

The transcripts reveal that students rarely approached problems by searching for a single correct answer. Instead, they engaged in iterative cycles of proposing ideas, questioning assumptions, evaluating alternatives, and refining solutions in response to peer feedback. Expressions such as *"What if..."*, *"Could..."*, *"Should..."*, and *"Would that work?"* illustrate a willingness to explore possibilities, tolerate uncertainty, and adapt thinking as new ideas emerged. Rather than abandoning unsuccessful ideas, students frequently modified and recombined existing ideas, demonstrating flexibility and persistence throughout the problem-solving process.

Student dialogue also highlighted the collaborative nature of adaptive capacity. Questions such as *"Can I..."* and *"Do you want to..."* reflected continual negotiation of ideas and consideration of teammates' perspectives, substantiate that students viewed creativity as a shared rather than an individual endeavor. These interactions demonstrate embodied thinking through active listening, perspective taking, and collective decision making.

Evidence of pattern recognition, abstraction, and modeling appeared throughout the conversations as students drew analogies, predicted outcomes, and mentally simulated possible solutions before acting. References to familiar structures such as the Eiffel Tower or the Space Needle illustrate how students transferred prior knowledge to unfamiliar situations, while repeated use of words such as *"try," "work,"* and *"make"* reflected iterative testing and refinement of ideas. Humor, imaginative play, and speculative questions further indicated that students felt comfortable exploring unconventional possibilities without fear of immediate evaluation.

Discourse analysis reveals that adaptive capacity was expressed not as isolated moments of creativity but as a continuous process of collaborative inquiry. Students repeatedly generated

possibilities, evaluated evidence, integrated prior knowledge, revised their thinking, and built upon one another's ideas while working toward shared solutions. These conversational patterns complement the quantitative findings by providing authentic evidence that repeated participation in low-stakes creative challenges fostered the interconnected cognitive, behavioral, and social processes that support adaptive capacity.

2.2.1 Frequency of Word Choice vs. Creative Habits

Figure 7

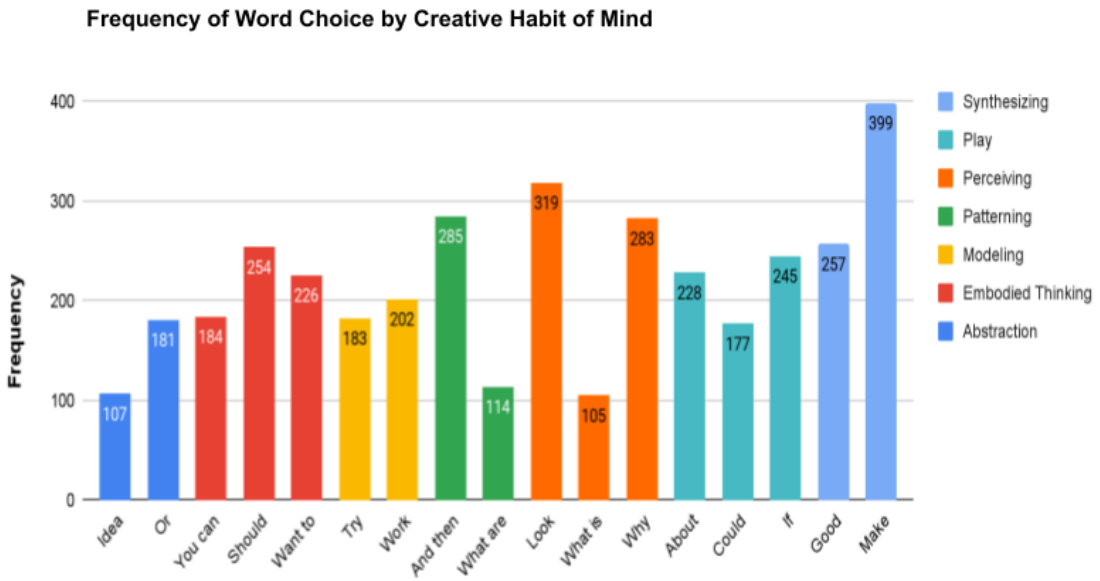


Figure 7 illustrates the frequency with which creative habits of mind were observed in student conversations during the three creative challenges. Curiosity, pattern recognition, and the application of prior knowledge were the most frequently observed habits, indicating that students regularly explored possibilities, drew connections to previous experiences, and built upon existing knowledge while solving ill-structured problems. Habits such as abstraction, modeling, and play occurred less frequently but were evident throughout the activities illustrating that students employed a range of complementary thinking strategies. The distribution of creative

habits of mind supports the conclusion that adaptive capacity was expressed through multiple interconnected cognitive processes rather than a single creative skill.

2.2.2 Word Choices vs. Creative Habits of Mind

Figure 8 *Percentage of Word Choices According to Creative Habits of Mind Classification*

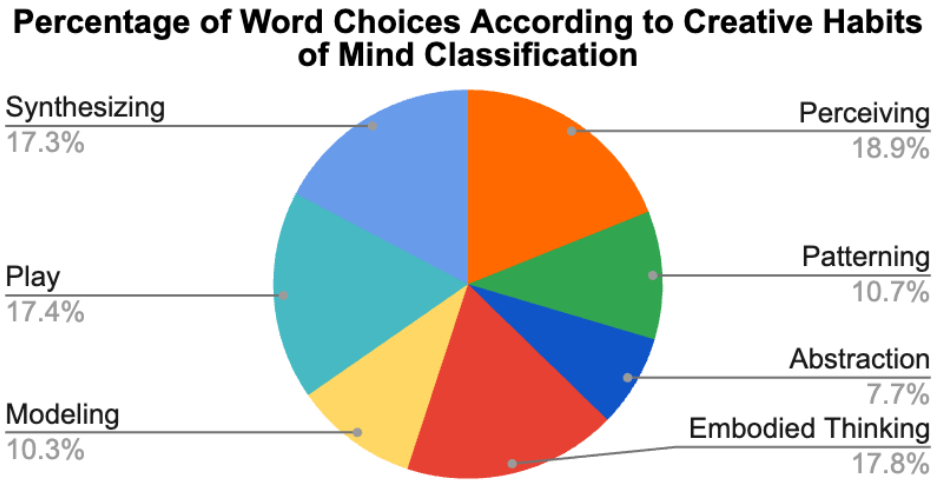


Figure 8 illustrates the distribution of creative habits of mind demonstrated during the collaborative creative challenges. While some habits occurred more frequently than others, students exhibited evidence of all seven habits throughout the intervention. Adaptive capacity was not characterized by reliance on a single cognitive strategy but rather by the coordinated use of multiple habits of mind. The percentages reinforce the view that adaptive capacity is demonstrated through the creative navigation of ill-structured problems, as students integrated curiosity, flexible thinking, prior knowledge, collaboration, and iterative refinement to develop and refine their solutions.

2.2.3 Summary of Student Discourse

Analyses of student dialogue showed that adaptive capacity was expressed through iterative questioning, collaborative reasoning, playful experimentation, and continual

refinement of ideas. Students demonstrated that creative problem solving was not a linear process but an ongoing cycle of imagining, evaluating, revising, and integrating multiple perspectives.

Discussion

Development of Adaptive Capacity

The purpose of this study was to examine whether repeated participation in low-stakes creative challenges strengthened students' adaptive capacity. Adaptive capacity was conceptualized as the integration of creative self-efficacy, creative personality, creative habits of mind, and divergent thinking. While paired *t*-tests indicated little change in overall mean scores across these measures, the relationships among them became substantially stronger following the intervention. Correlation, chi-square, and regression analyses consistently demonstrated that creative habits of mind became more closely associated with creative self-efficacy and creative personality. The intervention strengthened the interconnected dimensions of adaptive capacity rather than producing large changes in individual constructs.

Creative Self-Efficacy

Students entered the study with relatively high perceptions of their own creativity. One hundred percent of participants identified themselves as creative before and after the intervention, and most reported confidence in solving difficult or creative problems. However, following repeated engagement with increasingly complex, ill-structured challenges, students became somewhat less certain about their ability to generate original solutions. Rather than indicating a decline in adaptive capacity, this pattern may reflect a more realistic understanding of creative problem solving. According to the unskilled-and-unaware effect, individuals with limited experience often overestimate their abilities, while greater experience leads to more

accurate self-assessment (Kruger & Dunning, 1999; Urban & Urban, 2021). In this context, students' increased awareness of the complexity of creative thinking may represent an important stage in developing adaptive capacity rather than a loss of confidence.

Although average scores changed little, the intervention altered how students perceived the relationships among their creative behaviors, dispositions, and confidence. Following the intervention, students who reported stronger creative habits of mind were also more likely to report higher creative self-efficacy and stronger creative personality. In other words, the intervention provided opportunities for increased integration among cognitive, behavioral, and affective dimensions (rather than through dramatic gains in any single measure), thereby developing students' adaptive capacity..

Adaptive Capacity and Creative Mindset

Creative mindset reflects individuals' beliefs about the nature of their own creativity and whether creative ability can be developed through effort and experience (Hass et al., 2016; Karwowski, 2014). Within the adaptive capacity framework, a malleable creative mindset represents an important mechanism that supports adaptation because it encourages individuals to persist through uncertainty, view challenges as opportunities for growth, and refine their thinking in response to new experiences. Rather than functioning as an isolated personality trait, creative mindset influences how individuals approach complex problems, interpret setbacks, and regulate their learning.

Participation in repeated, low-stakes creative challenges seems to support the development of these adaptive dispositions. More than 30% of students reported higher post-intervention scores on survey items related to perseverance and grit, while the percentage of students reporting frustration with difficult work declined by 6%. Therefore, it seems that

repeated engagement with ill-structured problems in an environment emphasizing student choice, experimentation, and productive failure may strengthen students' willingness to persist through uncertainty. Such persistence and resilience are fundamental components of adaptive capacity because they enable learners to continue generating, evaluating, and refining ideas when solutions are not immediately apparent.

The quantitative analyses further support this interpretation. Although mean scores changed only modestly, the relationships among creative personality, creative habits of mind, and creative self-efficacy became stronger following the intervention. In particular, students who perceived themselves as demonstrating stronger creative habits of mind were increasingly likely to perceive themselves as having both higher creative self-efficacy and a stronger creative personality. Repeated creative experiences did not simply increase students' confidence; instead, they strengthened the integration of the dispositions, behaviors, and beliefs that support adaptive capacity.

Graphic analysis (Figures 2a and 2b) further illustrates this strengthening relationship. Following the intervention, students with stronger perceptions of their creative habits of mind also demonstrated stronger perceptions of their creative personality than before the intervention. Because mindset influences how individuals interpret challenges, respond to uncertainty, and persist through setbacks, it functions as an important mechanism through which adaptive capacity develops. Rather than viewing creativity as a fixed characteristic, students increasingly appeared to recognize creativity as a process requiring experimentation, reflection, and continued growth. This shift toward a more adaptive creative mindset may help explain why the relationships among the dimensions of adaptive capacity became more closely aligned, even though overall mean scores changed relatively little.

Creative Habits of Mind as Mechanisms of Adaptive Capacity

Observations in this study substantiate the idea that creative habits of mind function as mechanisms through which adaptive capacity develops. Rather than representing isolated creative traits, habits such as curiosity, play, abstraction, pattern recognition, modeling, and the application of prior knowledge enable students to respond productively to uncertainty, adapt their thinking, and persist while solving ill-structured problems. Within this framework, adaptive capacity is expressed not through a single creative act but through the coordinated use of multiple cognitive and behavioral processes that allow learners to generate, evaluate, and refine solutions as new information becomes available.

Survey results support this interpretation. Following the intervention, more students reported that they could handle stressful situations effectively, suggesting that repeated exposure to ill-structured challenges helped students become more comfortable navigating uncertainty. At the same time, some students reported being less certain about knowing exactly how to proceed when beginning a task. Rather than indicating confusion, this finding may reflect a greater awareness of the complexity of authentic problem solving. As students generated more possible solutions and considered multiple pathways, the process became less linear and more iterative. This interpretation is consistent with the development of adaptive capacity, which requires learners to tolerate ambiguity while continually adjusting their thinking in response to changing conditions.

One of the largest gains was observed in students' perceptions of play, defined as open-ended exploration leading to unexpected combinations of ideas, materials, or solutions. Play encourages experimentation, imagination, and the willingness to test possibilities without immediate concern for correctness. Hammershøj (2021) describes play as an essential component

of the creative process because it allows individuals to explore alternatives, shift perspectives, and generate novel ideas. In the present study, play was also among the most frequently observed creative habits during classroom observations and student discourse. Students increasingly viewed exploration and experimentation as productive components of problem solving rather than distractions from it.

The classroom observations further demonstrated that different creative challenges elicited different mechanisms of adaptive capacity. The inventing task encouraged high levels of abstraction as students imagined possibilities beyond familiar solutions. The engineering challenge required students to draw extensively upon prior knowledge while continually testing and revising structural designs. Technology-based storytelling relied more heavily on planning and synthesis but elicited comparatively fewer observable creative habits of mind. These differences evoke the idea that adaptive capacity is context dependent; different learning experiences activate different combinations of creative habits depending on the nature of the problem being solved.

Student conversations provided particularly strong evidence that adaptive capacity developed through iterative thinking rather than through isolated moments of insight. Transcript analyses revealed frequent questioning, hypothesis generation, collaborative negotiation, and continual refinement of ideas. Students regularly asked questions such as "What if...?", "Could we...?", and "Would that work?" before modifying or extending one another's suggestions. These exchanges demonstrate that students were continuously evaluating feedback from peers and adjusting their thinking in response. Such iterative feedback is an essential component of developing both creativity and critical thinking because it encourages learners to evaluate alternatives, revise solutions, and strengthen their reasoning (Widiastuti et al., 2020, 2022).

Students also drew upon familiar examples, recognized patterns, recombined ideas, and evaluated alternative approaches before selecting a course of action. Collectively, these conversational patterns illustrate adaptive capacity in action by showing that students were not simply producing creative products but engaging in flexible cycles of exploration, feedback, evaluation, and revision as they responded to novel situations.

Although Divergent Association Task (DAT) scores changed little across the entire sample, students who perceived themselves as demonstrating stronger creative habits of mind were more likely to obtain higher divergent thinking scores. Divergent thinking can therefore be understood as one manifestation of adaptive capacity rather than its defining feature. The quantitative analyses similarly demonstrated that creative habits of mind became more closely aligned with creative self-efficacy and creative personality following the intervention, with the implication that repeated engagement in creative problem solving strengthened the integration of these dimensions.

Together, the survey, observation, and transcript data indicate that creative habits of mind are not merely indicators of creativity but the behavioral mechanisms through which adaptive capacity is enacted. As students repeatedly engaged in low-stakes creative challenges, they learned to tolerate ambiguity, collaborate with peers, apply prior knowledge in new contexts, generate multiple possibilities, and refine their thinking through experimentation and reflection. These interconnected behaviors provide qualitative evidence explaining the quantitative finding that adaptive capacity became increasingly integrated over the course of the intervention.

A Classroom Ecosystem that Supports Adaptive Capacity

In this study, adaptive capacity developed not only through repeated engagement in creative challenges but also through participation in a classroom ecosystem intentionally

designed to support exploration, collaboration, and productive risk taking. Adaptive capacity does not develop in isolation; rather, it emerges through interactions among learners, teachers, peers, learning tasks, and the classroom environment. The combination of psychological safety, student choice, productive failure, and intrinsic motivation created conditions in which students could experiment with ideas, revise their thinking, and develop greater confidence in their ability to respond to uncertainty.

Many of the characteristics observed in this classroom align with conditions identified in the literature as supporting both creativity and adaptive learning. Starko (2010) argues that creativity is often constrained by highly structured educational environments emphasizing evaluation, surveillance, competition, external rewards, and predetermined answers. These practices may discourage intellectual risk taking by encouraging students to seek the "correct" answer rather than explore multiple possibilities. In contrast, adaptive capacity requires learners to tolerate ambiguity, generate alternatives, and persist despite uncertainty.

The classroom observed in this study intentionally reduced many of these barriers. Students were provided with open-ended challenges that emphasized multiple possible solutions rather than single correct answers. They selected approaches, collaborated with peers, experimented with materials, and revised ideas without fear that unsuccessful attempts would negatively affect grades. This environment normalized uncertainty as an expected part of learning and encouraged students to view setbacks as opportunities for refinement rather than indicators of failure.

Psychological safety appeared to play a particularly important role in supporting adaptive capacity. Starko (2010) suggests that students are more willing to take intellectual risks when mistakes are accepted as natural components of learning. Similarly, Henriksen et al. (2021),

Kapur (2015), and Bolander Laksov and McGrath (2020) argue that productive failure promotes deeper learning by encouraging learners to reflect, revise, and improve their thinking. Throughout the intervention, students repeatedly generated ideas, tested possibilities, evaluated peer feedback, and modified their approaches rather than abandoning unsuccessful attempts. These iterative cycles of exploration and revision were evident in both classroom observations and student discourse, with adaptive capacity developing through repeated opportunities to learn from uncertainty rather than avoid it.

Student choice also contributed to the development of adaptive capacity. Open-ended tasks allowed students to determine how they would approach each challenge, distribute responsibilities, and communicate their solutions. This autonomy encouraged ownership of the learning process while increasing opportunities for curiosity, experimentation, and the application of prior knowledge. Rather than following prescribed procedures, students continually adapted their strategies in response to new ideas, peer feedback, and emerging constraints. These experiences provided authentic opportunities to practice the flexible thinking required for adaptive capacity.

The classroom environment itself further supported these processes. To evaluate the extent to which the learning environment promoted creativity and adaptive learning, the classroom was examined using the Support for Creativity in a Learning Environment (SCALE) framework (Richardson & Mishra, 2018). The SCALE assesses the physical environment, learning climate, and learner engagement that support creative learning. Results are presented in Table 13.

Table 13 *Observation Site Scores Awarded by the Researcher Using the SCALE (Richardson & Mishra, 2018)*

SCALE CRITERIA	Research Site Rating	Examples from Task One: Build a Better Bug

	(0-3)	
Physical Environment		
A variety of resources are available and accessible to students.	3	There is a maker space in the room that students have access to; to ensure equity, students were given a specific but varied set of materials with which to work.
Examples of student work appear in the space.	2	Bugs had their own display shelf.
A variety of work stations or areas are available to students.	2	There are two work counters, a high-top table outside the classroom door, and desks are in pods inside the room. Students were permitted to choose where to work.
The furniture allows for multiple arrangements and configurations.	3	Desks are moveable.
Learning Climate		
Students are involved in discussions among themselves, with or without the teacher, that deepen their understanding.	3	Students worked together to solve the problems without teacher direction or intervention (other than time reminders).
The students are caring, respectful, and value differences.	3	Students had an easy camaraderie with one another and most were willing to work with others.
The teacher is a facilitator, co-learner, explorer, or inquirer with students.	3	The classroom teacher asked questions and clarified norms.
Mistakes, risk-taking, and novel ideas are valued or encouraged.	3	Students enjoyed trying out new ideas. One group used the scissors as pincers for their bug.
Learner Engagement		
Students are involved in tasks that are open-ended and/or involve choice.	3	No specific instructions were given on how to make the bug or how to present their bugs to the class.
Students are involved in activities that may include inquiry, project-based learning, or interdisciplinary tasks.	3	Other than the small creative tasks, some tasks require content knowledge.
Students use multiple perspectives/viewpoints/ways of knowing or various modes of investigation/problem-solving.	3	When not working on small, creative challenges, students may choose the projects they want to work on.
Students demonstrate interest in or enthusiasm for the activity beyond being “on task.”	3	One group made a stop-motion video to share the characteristics of their better bug.
Students spend time developing ideas for deeper understanding and/or reflecting on their learning.	3	Before points are awarded, students are required to share what they learned and reflect on the strengths and weaknesses of both product and process.
Students work at their own pace and/or time is used flexibly.	3	Tasks other than the small, creative challenges are worked on at a student’s own pace.

The classroom received a score of 36 out of 42, indicating a learning environment that strongly supported the development of adaptive capacity. High ratings in learner engagement reflected students' opportunities to participate in open-ended, inquiry-based tasks, collaborate with peers, and pursue multiple solution pathways. Similarly, high ratings in learning climate indicated that mistakes, risk taking, and novel ideas were consistently encouraged. The physical environment also promoted adaptive learning by providing flexible workspaces, accessible materials, and opportunities for students to select resources appropriate to their chosen solutions. These components of the classroom ecosystem provided the conditions necessary for students to practice curiosity, experimentation, collaboration, and reflection while responding to complex problems.

Viewed as a whole, the classroom ecosystem provides an explanation for the quantitative results of this study. Although average scores on individual measures changed only modestly, repeated participation in psychologically safe, low-stakes creative experiences strengthened the relationships among creative self-efficacy, creative personality, and creative habits of mind. The classroom environment provided opportunities for students to repeatedly practice curiosity, persistence, collaboration, reflection, and flexible thinking while solving authentic, ill-structured problems. Rather than simply increasing creativity, the ecosystem supported the integration of the cognitive, behavioral, and affective dimensions of adaptive capacity, helping students develop a more cohesive and resilient approach to novel challenges.

Conclusion and Implications

Conclusion

Overall, the results of this study support the hypothesis that repeated participation in low-stakes creative challenges strengthened students' adaptive capacity by increasing the integration of creative self-efficacy, creative habits of mind, and creative personality. Although mean scores changed only modestly, post-intervention analyses demonstrated stronger relationships among these dimensions, indicating that students developed a more cohesive understanding of themselves as creative problem solvers. Students who perceived themselves as engaging in stronger creative habits of mind were increasingly likely to report higher creative self-efficacy and a stronger creative personality, suggesting that adaptive capacity develops through the interaction of cognitive, behavioral, and affective processes rather than through growth in a single construct.

These observations challenge the common perception that creativity occurs only through spontaneous inspiration. Instead, they support a growing body of research demonstrating that creativity—and, more broadly, adaptive capacity—can be cultivated through intentional practice, domain knowledge, planning, reflection, and repeated engagement with authentic problems (Benedek & Jauk, 2019; Conner et al., 2018). The qualitative analyses further illustrate that adaptive capacity is enacted through observable behaviors such as curiosity, abstraction, collaboration, play, application of prior knowledge, and iterative refinement, all of which enable learners to respond flexibly to novel and uncertain situations.

The study also highlights the critical role of the classroom ecosystem in fostering adaptive capacity. Highly structured curricula, an emphasis on standardized testing, and environments that reward only correct answers may discourage intellectual risk taking, limit

exploration, and constrain students' willingness to adapt their thinking. In contrast, psychologically safe classrooms that encourage productive failure, student choice, collaboration, and reflection provide opportunities for students to practice the habits of mind and adaptive behaviors required to navigate complex, ill-structured problems.

Adaptive capacity is not an innate characteristic possessed by only a few creative individuals but a developmental capability that can be strengthened through purposeful classroom experiences. By designing learning environments that value experimentation, reflection, and multiple pathways to success, educators can help students integrate creative confidence, creative dispositions, and adaptive problem-solving behaviors. Such experiences prepare learners not only to think creatively but also to respond effectively to the uncertainty, complexity, and continual change that characterize an increasingly technology-rich world.

Implications/Recommendations for Action

Adaptive capacity can be intentionally cultivated through classroom practice. As artificial intelligence increasingly automates routine cognitive tasks, the ability to adapt, think flexibly, collaborate, and respond effectively to novel situations will become increasingly important. While creativity has long been recognized as a valuable twenty-first-century skill, adaptive capacity provides a broader educational goal by integrating creative self-efficacy, creative habits of mind, creative dispositions, and the ability to navigate uncertainty. Preparing students for an increasingly technology-rich world therefore requires learning experiences that extend beyond the acquisition of content knowledge to include opportunities for flexible thinking, experimentation, and iterative problem solving.

The results of this study suggest that developing adaptive capacity does not require major curricular redesign or lengthy creative projects. Instead, teachers can embed brief, low-stakes

creative challenges into existing instruction across all subject areas, including science, mathematics, language arts, social studies, world languages, and the arts. These "creative moments" encourage students to generate multiple solutions, apply prior knowledge in new contexts, collaborate with peers, and refine ideas through reflection and feedback. Because the activities require relatively little instructional time, they provide a practical approach for integrating adaptive learning into standards-based curricula without sacrificing required content.

An equally important implication concerns students' perceptions of their own abilities. Most participants entered the study believing they were creative, yet repeated engagement in authentic, ill-structured problems helped students develop a more integrated understanding of their creative confidence, dispositions, and behaviors. This finding suggests that educators should expand students' understanding of creativity beyond artistic talent or exceptional achievement. Helping students recognize creativity as an everyday process of questioning, experimenting, revising, and learning from feedback may strengthen their willingness to engage with complex problems and persist when solutions are not immediately apparent.

The classroom ecosystem also emerged as a critical factor in the development of adaptive capacity. The learning environment examined in this study received a high score on the Support for Creativity in a Learning Environment (SCALE) framework (see Table 13), reflecting strong support for student choice, collaboration, inquiry, psychological safety, and productive risk taking. These characteristics provided opportunities for students to experiment with ideas, receive feedback, revise their thinking, and learn from failure without fear of negative consequences. Such environments encourage the integration of confidence, creative dispositions, and adaptive behaviors that students need to respond effectively to uncertainty.

Educators must begin to view adaptive capacity as a teachable outcome rather than an innate characteristic. By intentionally designing classroom ecosystems that value curiosity, experimentation, productive failure, collaboration, and reflection, schools can help students develop the confidence and flexibility needed to navigate increasingly complex academic, professional, and societal challenges. Rather than preparing students simply to recall existing knowledge, education can prepare learners to adapt, innovate, and continue learning throughout their lives.

Limitations

Several limitations should be considered when interpreting the findings of this study. First, the sample size was relatively small ($N = 34$), and the intervention was conducted over a single nine-week quarter. Although the results indicate that repeated participation in low-stakes creative challenges strengthened the integration of adaptive capacity, a larger sample and longer implementation period would provide greater statistical power and allow researchers to examine whether these relationships continue to strengthen over time.

Second, the study was conducted in an elective projects course rather than a core academic classroom. Students were engaged in authentic, ill-structured problem solving without the pressures associated with mastering specific content or preparing for high-stakes assessments. As a result, they were less likely to experience the tension between exploratory, adaptive thinking and the demands of content coverage and standardized testing that characterize many core classrooms. Consequently, these conclusions drawn as a result of this study may not fully generalize to more structured instructional settings where opportunities for open-ended exploration are more limited.

Third, the survey instrument included a neutral response option, allowing students to select a middle category rather than indicating agreement or disagreement. While this approach may have captured uncertainty in students' self-perceptions, it may also have reduced the sensitivity of the instrument to detect meaningful changes over time. Future studies might consider using a forced-choice response format to determine whether stronger patterns emerge.

Finally, although all three intervention tasks were designed to promote adaptive thinking, they varied in the degree of openness and student autonomy they afforded. The engineering challenge, for example, emphasized constructing the tallest tower, whereas a less constrained design challenge might have encouraged a broader range of creative responses. Similarly, the storytelling task limited students to a predetermined set of images rather than allowing them to identify or create their own. Providing greater opportunities for student choice and multiple solution pathways may further strengthen the development of adaptive capacity by increasing opportunities for experimentation, divergent thinking, and iterative problem solving.

Despite these limitations, the study provides preliminary evidence that repeated engagement in brief, low-stakes creative challenges can strengthen the relationships among creative self-efficacy, creative personality, and creative habits of mind. Future research conducted across longer periods, in core academic subjects, and with larger and more diverse samples will help determine the extent to which adaptive capacity can be intentionally cultivated across a variety of educational contexts.

Recommendations for Future Research

This study provides preliminary evidence that adaptive capacity can be strengthened through repeated participation in brief, low-stakes creative challenges. Future research should examine whether similar outcomes occur across larger and more diverse student populations,

different grade levels, and core academic subjects where instructional demands and accountability pressures differ from those of an elective classroom. Longitudinal studies would also help determine whether the stronger relationships observed among creative self-efficacy, creative personality, and creative habits of mind are sustained over time and whether they transfer to new learning contexts.

Future investigations should also expand the ways adaptive capacity is measured. In addition to self-report surveys, researchers should examine students' perceptions of the learning experiences that most effectively support adaptive capacity. For example, students could be asked when and where they feel most capable of adapting to new challenges, what characteristics define an environment in which they are willing to take intellectual risks, what types of classroom activities encourage them to persist through uncertainty, and which teacher behaviors increase their willingness to explore, revise, and collaborate. These perspectives would provide valuable insight into how classroom ecosystems can be intentionally designed to cultivate adaptive capacity.

Further research should also explore the role of specific instructional practices in supporting adaptive capacity. Psychological safety, productive failure, student choice, reflection, and collaborative problem solving contribute to stronger integration among creative self-efficacy, creative personality, and creative habits of mind. Future studies could investigate the relative influence of each of these factors, as well as the extent to which adaptive capacity is enhanced by structured opportunities for feedback, metacognitive reflection, and iterative revision.

Finally, future research should continue examining the relationship between adaptive capacity and divergent thinking. While the present study found that divergent thinking remained only modestly related to the self-perception measures, adaptive capacity encompasses broader

cognitive, behavioral, and affective dimensions than divergent thinking alone. Additional research using multiple measures of adaptive performance and creative problem solving may provide a more comprehensive understanding of how students learn to respond effectively to novel, uncertain, and increasingly complex challenges.

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