Introduction to Intentional Ideation Methodology for Engineering Students – Initial Perceptions

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Introducing Engineering Students to Idea Generation Methodologies in a Multidisciplinary Capstone Design Course: Preliminary Results and Insights

Abstract

Ideation is the process of generating ideas. Engineering relies on generating ideas and transforming them into products, processes, and systems; hence, ideation is a critical skill for future engineering practitioners, innovators, and researchers. To help students learn and develop ideation skills, two intentional ideation approaches were incorporated into a multidisciplinary project course in the Herbert Wertheim College of Engineering at the University of Florida. The students were introduced to the concept of intentional ideation in a workshop setting. The two intentional idea generation techniques of Brain Writing and Semantic Intuition were introduced. For both exercises, students were asked to sit together and work in their project groups. After the workshop, an anonymous survey was distributed that invited students to respond to a set of reflection prompts to describe their experience and share their opinions about these two ideation processes. Data was collected in the Fall 2025 semester when 151 students were enrolled in the course; 150 students consented to participate in the study and their responses were collected. The students' responses to the reflection prompts in the post-workshop survey and workshop output were entered as data for the study. The student responses to the reflection prompts on Brain Writing and Semantic Intuition were qualitatively analyzed, using both closed and open coding, to investigate whether these activities served as useful aids to learn and practice intentional ideation. Closed coding results indicate that 82.67% of participants reported Brain Walking to be positive for their concept generation, 4% did not see it as positive, and 13.33% were neutral. Similarly, 52.67% of participants reported Semantic Intuition to be positive for their concept generation, 29.33% did not see it as positive, and 18% were neutral. Furthermore, open coding results indicated that students observed various types of beneficial gains for themselves (i.e., individual), their team (i.e., group), and their team's concept generation (i.e., task). While benefits for the individual included perspective shifts, self-understanding as well as having a structured method to use, benefits for the group were described as collaboration, overcoming group challenges along with cohesion. Finally, benefits for the task included quantity, quality, diversity, and iterative refinement of ideas. While Brain Walking benefits were distributed relatively evenly across individual, group, and task domains, Semantic Intuition benefits were primarily for the individual, with less impact on the group or the task. A demonstrative example of how students made use of these processes as they collectively thought about a given problem definition is also provided.

Keywords. Ideation Methods, Design Methods Frameworks and Mindsets, Brain Writing, Semantic Intuition, Qualitative Analysis

Introduction

Engineering relies on generating ideas and transforming these ideas into products, processes, and systems. Hence, idea generation is an important element of the engineering design process and a critical skill for future engineering practitioners, innovators, and researchers. Many engineering students are not trained in various idea generation processes formally throughout their education. Although almost all engineering students take multiple design courses throughout their education, they might not be trained in idea generation as part of their formal coursework, unless the instructor of the course has some experience and/or interest in facilitating idea generation sessions.

A critical review of the existing engineering education curricula shows that the strong emphasis placed on technical aspects of engineering education curriculum that trains students finding the correct solution of a problem might lead to engineering students to struggle with creating ideas [1] - [3]. Furthermore, with their inherently strong analytical and critical thinking skills engineering students demonstrate a tendency to screen their ideas as they go and avoid ideas that may appear to be technically infeasible without examining them sufficiently [4]. Also, some evidence in the literature suggests that students need a supportive and safe environment to share their ideas without the fear of being judged [5], [6]. Hence, as curricula that focus on idea generation skill development are developed and implemented, the set of concerns that are specific to engineering education and engineering students need to be considered.

To help students learn and develop idea generation skills, an idea generation workshop was incorporated into the first semester of a two-semester multidisciplinary engineering capstone course sequence (EGN4951C and EGN4952C) at the University of Florida, during the Fall 2025 semester of the 2025-2026 course sequence. This study investigates student experiences and potential benefits of using two idea generation processes, Brain Writing (BW) and Semantic Intuition (SI), using qualitative analysis. Responses were first examined wholistically with closed coding to assess overall experience, and then responses were broken down, and open coding was used to identify benefits from each exercise.

Background

Existing literature on creativity reveals that there is a myriad of idea generation processes [7] - [10]. A related line of existing literature suggests that generating a lot of ideas and entertaining a wider scope leads to better ideas [11], [12]. Also, higher levels of creativity can be demonstrated, and more surprising and revolutionary ideas can be generated when more ideas are generated, and a broader scope is adopted. [13], [14]. Hence, there is a need to exercise care in choosing which idea generation processes to choose for implementation in existing curricula in engineering education.

Existing literature on engineering design and innovation shows that various idea generation approaches have been incorporated into engineering education at different levels (e.g., freshman design [3], [15] and senior design [16], [17]) and in different courses (e.g., computer engineering [18], [19] and interdisciplinary engineering [19]).

For instance, TRIZ (Theory of Inventive Problem Solving) is a logic-based approach used for automating the creative process in the field of engineering. The TRIZ method implies that there is a set of principles that can be identified from sets of data, and logical conclusions can be made to help guide the ideation process [17]. One of the more useful benefits of TRIZ is the ability to improve self-efficacy in solving problems compared to classical brainstorming methods [20]. TRIZ is known for more novel ideas being created due to its use after numerous initial solutions have been presented [3]. However, it was not considered for the purpose of this study since the participants of the workshop had not generated initial solutions, and TRIZ requires extensive instructions which were not suitable for the class activity being conducted. The SCAMPER technique (Substitute, Combine, Adapt, Modify, Put to other users, Eliminate, and Reverse) is a method that uses general strategies and analogical thinking for generating new ideas and concepts by applying 7 transformations to an existing idea or solution [3]. Unlike TRIZ, the SCAMPER method relies more on intuition versus logic, and in past literature students have been presented with a series of questions that help to generate solutions beyond the default and obvious ideas from the pre-existing solutions [21]. Similarly to TRIZ, SCAMPER is a tool used to build off pre-existing ideas and does not apply to this study because the students did not have any baseline ideas generated to work from, therefore SCAMPER would not be used effectively.

One of the researchers on the team (EA), who also served as the facilitator for the workshop, has been involved in the development of innovative and creative thinking skills of engineering students and developing modules for ideation for several courses (e.g., Senior Design as well as courses on engineering design and engineering entrepreneurship) in the institution since 2013. Over the last decade, as she has experimented with the implementation and testing of various idea generation processes with engineering students, she gained direct, first-hand insight into some of the challenges that engineering students experience during idea generation sessions [7] - [9]. These challenges are associated with some of the well-documented blocks that limit one's creativity, including perceptual, emotional, cultural, and environmental as well as intellectual and expressive [22]. For instance, engineering students tend to limit themselves to a given problem definition too closely or demonstrate an inability to see a given problem from various viewpoints, which are both well-known conceptual blocks that might focus one's thinking too narrowly [22]. Similarly, engineering students tend to focus on utility and practicality of ideas that one can justify with reason and logic, which is a cultural block that might restrain one from adopting a playful approach to generate perhaps crazy and original ideas [22]. In addition, some engineering students exhibit low tolerance for ambiguity, a need for order, and no appetite for chaos, which is an emotional block that might limit one's ability to generate ideas for ill-defined problems [22]. Also, most engineering students tend to judge and criticize their own ideas as well as ideas given by others too quickly, which is a well-known emotional block, which can be quite detrimental to the idea generation process [22]. Lastly, in some group settings, outspoken and/or extroverted individuals may dominate idea generation which arises as an environmental block that could prevent quieter and/or more introverted group members from expressing their own ideas comfortably.

BW was developed at the Batelle Institute in Frankfurt, Germany to facilitate the parallel generation and processing of multiple ideas in groups [7, p.323]. Any individual or any group can design their own format for BW based on two fundamental principles: (i) ideas are generated by individuals in silence, and (ii) ideas are generated in parallel under a time limit. Enabling idea generation in silence ensures that all members of the group can express their ideas without feeling any pressure. Also, it ensures that the most vocal or senior or knowledgeable (perceived or real) members of the group do not dominate the ideation process and prevent some ideas from being expressed. Finally, silence ensures that ideas cannot be judged, criticized, or shot down as soon as they are offered. Similarly, as ideas are being generated on the spot in parallel, BW increases the number of ideas generated dramatically. BW Pool, BW 635, Constrained BW, and Pin Cards are related techniques [10], [23].

SI was also developed at the Batelle Institute to enable the generation of ideas by considering pairs of words [10]. One implementation of SI relies on the creation of a list of words and terms connected to a topic of interest and generation of word pairs. The discussion of the meaning or implications of word pairs can lead to fresh ideas and innovative solutions. Another implementation of SI relies on choosing the most important noun and verb, or the most important noun and adjective in a problem statement and generating lists of synonyms or semantically related words for them. Next, noun-verb pairs chosen from these lists are discussed and reflected upon to generate solutions for the problem of interest or to reframe the given problem statement. As in the case of BW, any individual or any team can design their own format for SI based on the principle of generating lists of words, generating pairs of words, and using these word pairs for ideation. Two Word, Noun-Adjective, and Noun-Verb are related techniques [10].

BW can be used successfully to generate a lot of ideas in a short amount of time without discussing, criticizing or judging them. Therefore, as an idea generation technique, it has the potential to help engineering students overcome some of the emotional, cultural, and environmental blocks they might experience. Similarly, SI can be used successfully to uncover the assumptions and challenge thinking around a given problem statement, again offering a potential to help engineering students overcome some of the commonly encountered perceptual and conceptual blocks. Hence, BW and SI were selected for the idea generation workshop.

Research Questions

This study focuses on an exploration of the students' experiences and the potential benefits of using BW and SI. To this end, the following research questions (RQs) are considered:

RQ1: Was the overall experience of BW in the workshop considered positive for concept generation?

RQ2: What beneficial gain, if any, do students report from the BW exercise?

RQ3: Was the overall experience of SI in the workshop considered positive for concept generation?

RQ4: What beneficial gain, if any, do students report from the SI exercise?

Study Design

Course. This study was conducted in EGN4951C: Integrated Product and Process Design course. In this capstone course, multidisciplinary teams of engineering and computer science students partner with industry sponsors to design and build authentic products and processes on time and within budget. Working closely with industry liaisons and a faculty advisor, students gain practical experience in teamwork and communication, problem solving and engineering design, and develop leadership, teamwork, communication, and other professional skills. Throughout the course several guest speakers are invited to deliver workshops or give talks to help students hone such professional skills. After each workshop or guest speaker, students are invited to respond to a set of questions to collect feedback about their assessment of and opinions about the workshop and/or the guest speaker. Questions for these surveys as well as anonymous response collection and analysis protocols have been reviewed and approved as exempt by the institution's IRB Board.

***Workshop: Idea Generation Training Content and Delivery*.** Students in the course participated in a 75-minute workshop during regular class time, designed to introduce intentional idea generation and provide structured, experiential practice. The workshop had three objectives: (i) to present idea generation as a teachable, structured, and goal-oriented process; (ii) to introduce BW and SI through guided practice on a facilitator-provided prompt; and (iii) to have teams apply one of these methods to their sponsor-defined project statements. The workshop was conducted in the following stages, with students working in their project teams throughout.

1. *Introduction:* Students were first asked to reflect on how they generate their "best" ideas, followed by a discussion on iterative idea generation and choosing a "good idea". The workshop then introduced four guiding rules with quotations from prominent idea generators in various fields: (1) be playful and rebellious, (2) defer judgment, (3) be curious, and (4) do the work (Appendix A, Table A.1). These rules encouraged participants to prioritize idea generation over feasibility, suspend evaluation to reduce self-critique and social anxiety, remain open to new perspectives, and stay engaged in the process.
2. *Warm-up Activity:* Students completed a partial prompt by generating as many humorous and creative responses as possible within two minutes. The facilitator then polled response counts, invited select students to share their ideas, and prompted brief reflection on their ideation strategies. This discussion highlighted key concepts in idea generation (e.g. fluency, flexibility, originality, and elaboration) and identified common limiting statements (Table A.2). The activity concluded with reminders for students to recognize (i) their own

prejudices, assumptions, and beliefs; (ii) their own cognitive patterns; and (iii) the cognitive patterns of others during idea generation.

3. *Brain Writing:* Students were first given a practice prompt and sample ideas (Table A.3) and reminded to remain playful, defer judgment, and adhere to time limits. An overview of BW (Table A.4) and a worksheet (Table A.5) were then provided. The facilitator introduced the prompt: *"Individualized and improved learning in engineering education."* The topic was selected to align with students' existing knowledge and experiences, consistent with principles of creative cognition [26]. The activity consisted of six two-minute rounds. In the first round, students independently generated one idea. At the end of each round, sheets were passed to the right. In subsequent rounds, students silently read the existing ideas and either added a new idea, improved an existing one, or combined ideas. Clarifying questions were not permitted. The facilitator monitored time using a stopwatch. After six rounds (12 minutes total), students reflected on group productivity, noting that idea generation scaled with group size (e.g., 42 ideas in a group of seven; 18 in a group of three). Emphasis was placed on silent focus and adherence to time constraints as key productivity factors. Students concluded by reflecting on their individual ideation strategies and how peers' ideas could serve as springboards for further idea development.
4. *Semantic Intuition:* The facilitator emphasized how language shapes problem framing, introduced the five steps of SI (Table A.6), and provided a worksheet (Table A.7). Using the research question, *"How might we individualize and improve engineering education?"*, students were reminded to remain playful, defer judgment, and adhere to time limits. Students first identified the most important noun and verb in the prompt. They then generated synonyms, related terms, and antonyms for each. Finally, they created new research questions by combining selected noun-verb pairs. Groups concluded by reflecting on the number of alternative terms and questions generated. The activity highlighted how reframing language and exploring alternative phrasing can expand problem and solution spaces and stimulate idea generation.
5. *Concept Generation for Course Projects*: During the final workshop session, student teams selected either BW or SI to develop concepts for their course projects. Based on their choice, teams received the corresponding worksheets (Appendix A) and were given 20 minutes to generate project-specific ideas.
6. *Post-Workshop Reflection*: Following the workshop, students completed a written reflection on their experiences with BW and SI. For each activity, they briefly described their experience (1-2 sentences) and identified perceived benefits for concept generation (2-3 sentences).

Data Collection

Participants. The course has a total of 151 students enrolled. The course is a dual-level course with 28 graduate and 123 undergraduate students. The graduate students are either pursuing a Master of Science (MS) degree in applied data science or an MS degree in artificial intelligence systems. The undergraduate students come from a broad range of engineering majors, such as computer and information sciences, mechanical and aerospace engineering, and electrical and computer engineering. Student teams are comprised of either solely undergraduate or solely graduate students. Team sizes varied between 4 and 7. The students enrolled in the course were distributed across 24 teams. Graduate student teams focus on artificial intelligence and data science projects, whereas undergraduate student teams work on projects spanning diverse types of engineering developments including proof-of-concept models, research-based prototypes, system integration designs, and production-ready solutions.

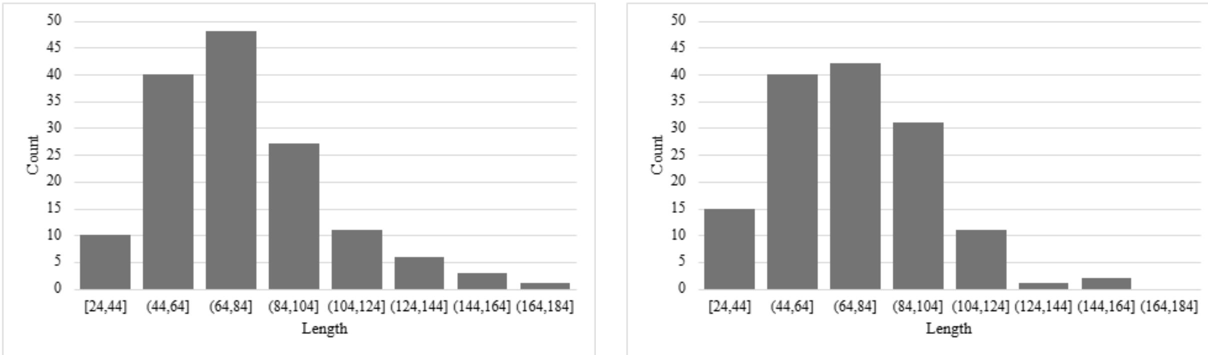
Data Collection Tools. Student responses to the warm-up activity and the student work completed using worksheets (see Appendix A.5 and A.7) during the workshop as well as the student responses to the post-workshop survey questions were entered as data for the study.

Study Data. Data was collected in Fall 2025 when 151 students were enrolled in the course. A total of 150 students consented to participate in the study, and 150 responses were collected by an anonymous survey. Two of the students who responded were not present in the workshop, but as the survey was anonymous and these students' responses could not be isolated, they are included in the data that was analyzed by the research team.

The participant responses to the post-workshop survey provide a rich data set for qualitative analysis. In all instances where quotations from the participants are presented, an identifier in the format XXX-BW or XXX-SI will be used. The XXX in this format denotes the participant identification number and BW or SI will indicate the description of experience with BW or SI, respectively. While Table I presents the summary data on the length of participant responses, Figures 1(a) and 1(b) show the frequency distribution of the response length. As can be seen from Table and Figures, the participants reflected deeply and in detail on their individual and team experiences on the two idea generation methodologies.

Table I. Number of words in participant responses.

	Number of Words in Participant Responses	
Response Length Statistic	**BW**	**SI**
Minimum	27	24
Maximum	172	161
Mode	80	65
Mean	76.69	72.52
Standard Deviation	27.26	23.99
Total	11,503	10,878



(a) (b)

Figure 1. Response length frequency distribution for (a) BW and (b) SI.

One member of the research team (EA) reviewed the worksheets to investigate how the processes unfolded for the teams during the workshop. While the analysis of these worksheets is beyond the scope of this study, a sample of students are provided in Tables Appendix B.1 and B.2 for ideas generated using BW and SI, respectively, for demonstration purposes.

Data Analysis

The participant responses were qualitatively analyzed to understand the participants' experiences with and investigate the students' perceptions of the benefits of BW and SI, respectively. Analysis of the study data was completed in two steps. First, to investigate if the overall experiences of the BW and SI activities in the workshop were considered positive (RQ1 and RQ3), the responses were analyzed wholistically using closed coding [27]. After this step was completed, the responses were broken down and analyzed further using open coding to identify the beneficial gains students reported from the BW and SI exercises (RQ2 and RQ4) [27].

Data analysis to answer RQ1 and RQ3. Participant responses to BW and SI were independently coded by five coders (EA, YK, ML, SCR, DAS) related to the students described experience. There were three coding options which were given a corresponding value: (1) negative experience, (2) neutral experience (i.e. neither positive nor negative), and (3) positive experience. The coders convened as necessary to discuss independent coding results. Discrepancies among codes assigned by different members of the research team were discussed offering explanations and alternatives for each option. After these discussions, a coder had the option of revising their codes, but they were not required to. In instances where consensus could not be reached, responses containing coding discrepancies were maintained in the data set and accounted for during scoring.

The individual scores were then summed into an overall experience score for each participant's response. These overall experience scores could have a range of 5 (all coders rated that the student had a negative experience), to 15 (all coders rated that that student had a positive experience). Below are a few examples to demonstrate the coding and the scoring process.

- For instance, a participant (017-BW) remarked, “I enjoyed Brain walking. I have a problem of being slow in group discussions and not being able to keep up with the team. But this was a nice exercise that I could be doing with my friends regularly to train ourselves to think faster. I think BW is a good exercise to train our minds to think faster. It also helps in building team coordination and understanding each other better.” This response was assessed to be a positive response by all coders and received a total score of 15.
- Similarly, another participant (062-SI) said, “Semantic intuition was a new method to me. I thought that it was very interesting however it did seem chaotic compared to brain walking. Some benefits to this method as compared to the other is that this makes you think more outside the box. By thinking about the problem in terms of different synonyms, it makes you truly consider other possible options. One big benefit is that it is a very quick way to get ~25 ideas you can build off of.” This response was interpreted to be positive by 1 coder and neither positive nor negative by the remaining 4, receiving a total score of 11.
- Another participant (025-SI) noted, “Personally I didn't enjoy the Semantic Intuition as much as the brain walking. It didn't get me into my creative flow and I think I can say that on behalf of my group. Some of the benefits of Semantic Intuition is definitely the ideation portion. I think ideas could be build upon similar to the Brain Walking, just not in the same way. A key thing I enjoyed about it was the freedom it provided as well, where ideas didn't have to be right or wrong.” This response was interpreted to be negative by two coders and neither positive nor negative by the remaining three, receiving a total score of 8.
- Finally, another participant (127-BW) noted, “It was interesting but I didn't really like it. I felt like it over-complicated the ideation process. The only foreseeable benefit I could see from brain walking is that it could help teams who struggle with the ideation process to build and create complex ideas that take everyone's perspective. The fact that everyone writes down one idea of their own first ensures everyone thinks about the problem beforehand. Passing the papers around ensures that everyone considers the others ideas and ultimately helps create one idea that incorporates everyone's.” This response was interpreted to be negative by all coders and received a total score of 5.

Data analysis to answer RQ2 and RQ4. Participant responses related to their experience with BW and SI were independently analyzed by five coders (EA, YK, ML, SCR, DAS) qualitatively using a thematic analysis. First, the research team read all the participants' responses to familiarize themselves with the data. Then the “meaning units” in participant responses from 001 to 030 were highlighted by 3 researchers each by EA, YK, DAS and EA, ML, SCR, respectively. The “meaning units” were anything from the participant survey that was relevant to the study. These 60 responses were discussed by the entire research team during weekly meetings to ensure that the members of the research team agreed upon the relevant meaning units. After a consensus was reached, the same subgroups of researchers identified the meaning units from all participant responses and convened weekly to compare, discuss, and modify emerging codes, categories, and themes. After all the participant responses were identified, the meaning units were extracted from the full text. Care was taken to ensure that the context and order remained, and the full responses were referenced throughout the remainder of the analysis to ensure the original meaning was not lost. Once all the meaning units were extracted, the total number of meaning units for each question and the number of meaning units per response were calculated.

The research team then broadly categorized the meaning units into three groups focusing on (1) participants' experience with BW and SI, (2) potential perceived benefits or pitfalls associated with BW and SI, and (3) other miscellaneous observations made by the participants. The initial classification was conducted by two researchers (YK, ML). To reach consensus, another researcher (DAS) joined the discussion to provide a third view.

As the focus of RQ2 and RQ4 was on what beneficial gain, the meaning units that were classified as benefits were analyzed further. EA and ML of the research team reviewed all these units and identified four categories: (1) benefit to the *Individual*, (2) benefit to the *Group* (or team), (3) benefit to the *Task*, and (4) other *Miscellaneous* benefits. The members of the research team (YK, ML, DAS) classified each of these meeting units individually and then met to discuss and modify until consensus was reached.

The meaning units in each of the benefit categories were then reviewed by one of the researchers (ML) to identify emerging themes. During this step, a cross categorical analysis of the meaning units was performed, and the identified benefit category for each meaning unit was finalized.

Results

Results Related to RQ1 and RQ3. Consensus in experience scoring was reached by all coders on 132 (88%) of the 150 responses for BW and 95 (63.33%) responses for SI. There were no instances where the coding team had such a difference in coding that an experience was rated as 1 (negative) and 3 (positive) by different coders. Therefore, responses that received a score of 10 were considered neutral by all members of the coding team. Of the 132 responses that had consensus for BW, 2.67% were coded as all negative, 13.33% were coded as all neutral, and 72.67% were coded as all positive. Of the 95 responses that had consensus for SI, 11.33% were coded as all negative, 18% were coded as all neutral, and 34% were coded as all positive

For any responses that did not have full consensus between the coding team, scores were then split into groups, Negative Majority, Negative Minority, Positive Minority, and Positive Majority. Scores of 6 and 7 were classed as Negative Majority as most of the coding team classified these as negative experiences, but there were 1 or 2 members who thought the experience was neutral. Scores of 8 and 9 were classed as Negative Minority as a minority of the coding team thought the experiences were negative. Scores of 11 and 12 were classed as Positive Minority as a minority of the coding team thought the experiences were positive. Lastly, Positive Majority consists of experience scores of 13 and 14 were a majority of the coding team thought the experiences were positive. The count of responses in each group is shown in Figure 2.

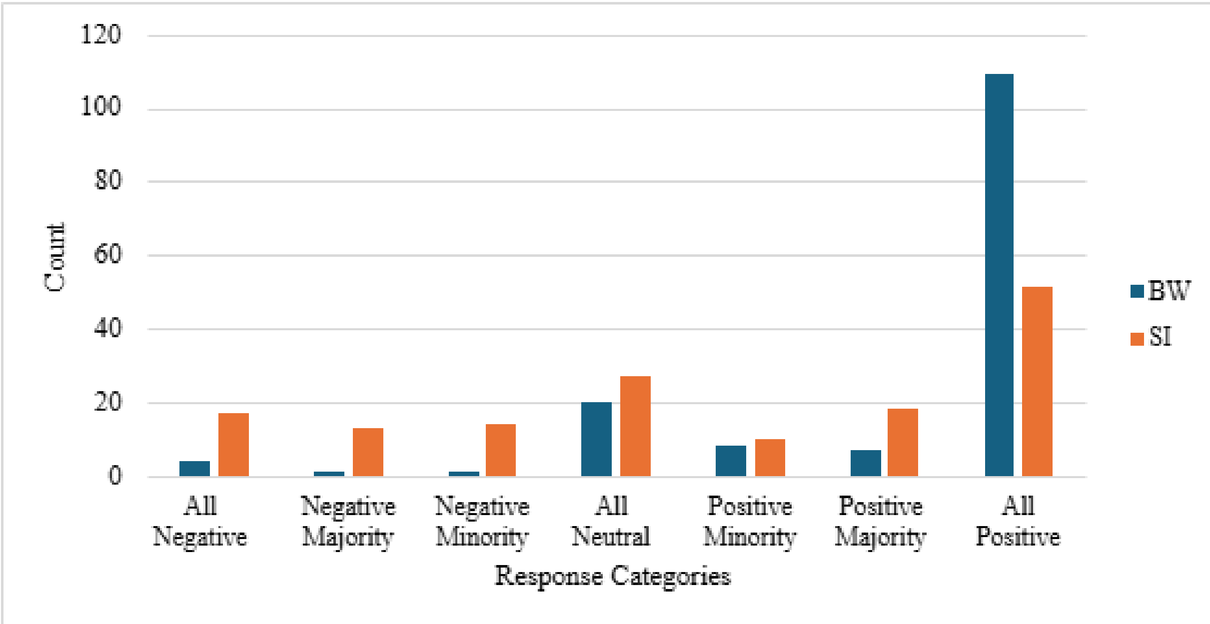


Figure 2. Count of responses for each group of experience scores.

Results Related to RQ2 and RQ4. For BW, 910 meaning units emerged. On average, there were 6.06 meaning units per response, with the minimum and maximum being 3 and 12, respectively. For SI, 866 meaning units emerged. On average, there were 5.77 meaning units per response, with the minimum and maximum being 3 and 11, respectively. Figures 3(a) and 3(b) show frequency distributions of the number of meaning units from each response.

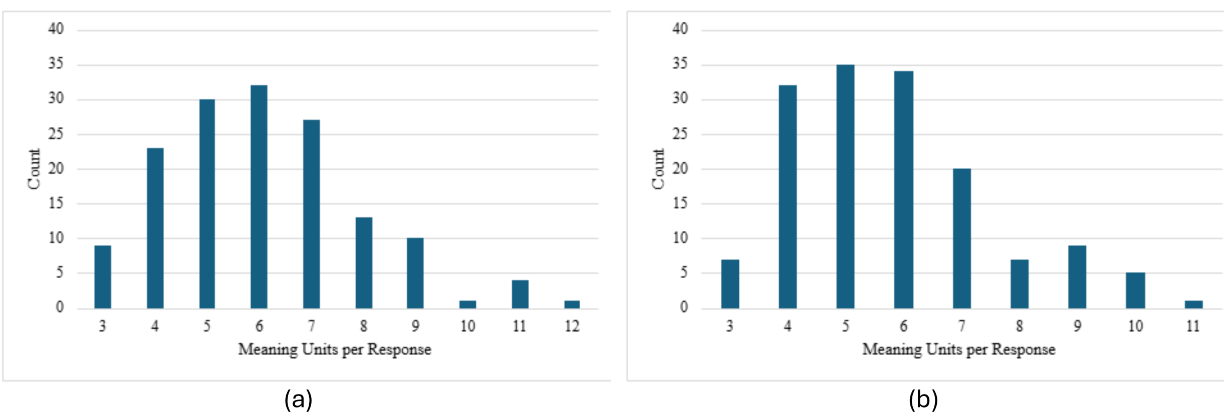


Figure 3. Meaning units per response frequency distribution for (a) BW and (b) SI.

Table II provides the count/percentage of the meaning units in each of the benefit categories: Individual, Group, Task, and Miscellaneous.

Table II. Count (Percent) of meaning units in each benefit category.

Benefit Category	**BW Count (Percent %)**	**SI Count (Percent %)**
Individual	231 (50.55)	270 (73.17)
Group	96 (21.01)	23 (6.23)
Task	109 (23.85)	64 (17.34)
Miscellaneous	21 (4.60)	12 (3.25)
Total	457	369

Each of the meaning units in the benefit categories were reviewed for common themes. Some meaning units covered multiple themes, and not all meaning units fell into the identified common themes. Therefore, units across all themes will not add up to the total number of meaning units in each benefit category.

Individual. An *individual benefi*t was anything that benefited the individual directly. This sometimes was related to being in a team such as seeing alternative perspectives but was focused on the individual's experience (e.g. "It allows you to see the perspectives and even biases of your team members" (020-BW)). This included perspective shifts, self-understanding, a structured method to use, and other benefits to the individual. Table V shows common themes that were identified in the individual benefits with counts of how many times that theme appeared.

Table V. Count of meaning units in common individual themes.

Themes: Individual	**BW Count**	**SI Count**
Perspective shift	44	81
Limiting challenges	44	13
Ease of use	22	2
Build/Springboard	26	5
Structured method	14	19
Process more creative	11	32
Think outside the box	2	9
Self-understanding	4	21
Scope generation	-	69

The most common individual-related themes include:

- Perspective shift – Participants commonly identified that these ideation approaches encouraged them to think from a different perspective or in a different way. This theme includes individuals better understanding their teammates. Examples include "Make you think in a different angle of view on a problem" (055-BW); "introduced you to other people's perspectives and ways of thinking, which might be very different from yours" (046-BW); "understand that it helps look at the question from a different lens" (044-SI); and "can...see through different perspectives which might give us some solutions" (134-SI).

- Limiting Challenges – There are many blocks that people face when they are ideating. Some of the individual benefits were the limitation or overcoming of these blocks such as reduced pressure, reduced distraction, less anxiety around sharing ideas, and overcoming individual biases. Examples include “gives everyone a chance to present their ideas without having to verbalize them or worry about perception” (099-BW); “it allows everyone to think on their own before working together to generate the final concept” (047-BW); “helps overcome fixed patterns of thinking in concept generation” (117-SI); and “help[s] overcome cognitive biases” (001-SI).
- Ease of use – The ease of using these ideation methods was also beneficial to the individual and noted in many meaning units for BW. Similar to the task benefit of efficiency, many students noted the time constraint as a benefit of these methods. Examples include “forces your brain to think of things fast and on the spot” (053-BW); “[prevents] getting bogged down in details” (090-BW); “helps get thoughts moving in a short period of time” (081-BW); “doesn't take a lot of effort” (034-SI); and “was to be able to come up with similar concepts and ideas quickly” (105-SI).
- Build/Springboard – Many meaning units identified the individual being able to build on their group members ideas. This is identified as an individual benefit as they are the ones who were building or using others' ideas in concept generation. Examples include “uses others' ideas as a spring board for ideation” (001-BW); “if I like a peer's idea, I can build off on it, without being prevented from introducing my own new ideas to the project” (049-BW); “(by changing some word) we might get a change to improve it completely” (134-SI); and “think ideas could be built upon (similar to BW) just not in the same way” (025-SI).
- Structured method – Having a method to follow benefits the individuals through deepening the understanding of how an idea progresses. Examples include “gives more structure to the process” (032-BW); “maintains a good flow of thoughts while staying on topic” (090-BW); “helps come up with a good outline” (035-SI); and “aids in focusing the process of ideation” (044-SI).
- Process more creative – While some meaning units mentioned that the task, idea, or outcome was more creative, others apply this creative element to the process of idea generation or see themselves as more creative from this process. Examples include “helps expand creativity” (109-BW); “encourages creativity by combining individual input with collective refinement” (069-BW); “help open up more unusual or unique ideas that you may not think of normally” (028-SI); and “(encourages) more innovative solutions” (109-SI).
- Thinking outside of the box – The phrase “thinking outside the box” appeared in 11 units. This could be interpreted as a perspective shift or the processing being more creative, which is why it was isolated into a separate theme. Examples include “help you think outside the box or look at the concept from a different angle” (046-BW); “made me think out of the box” (091-BW); “(benefits compared the BW) makes you think more outside the box” (062-SI); and “might be to think outside the box” (124-SI).

- Self-understanding – Participants also noted that they were able to challenge or understand themselves and the concept of language more thoroughly through the process of using these methods. Examples include "self-challenge" (013-BW); "important for understanding myself" (039-BW); "forces you to think about how different concepts associate with each other" (067-SI); and "directly challenges (language) limits" (001-SI).
- Scope Generation – SI also had individual benefits related to scope generation of the problem. This is where participants were able to better understand what the question or problem they needed to solve was asking. SI shifts the perspective of the problem rather than the perspective of the individual and as SI is focused on generating alternative noun/verb combinations of the question, it is particularly well suited for scope identification and generation. Examples include "better understand what the scope of the prompt is asking" (087-SI) and "need to have a good understanding of the words in (the prompt) to come up with similar words" (139-SI).

Group. A *group* benefit was identified as anything that benefited the group or team as a whole. Therefore, this included collaboration, overcoming group challenges, cohesion, and other notable group benefits. Table III shows common themes that were identified in the group benefits with counts of how many times that theme appeared.

Table III. Count of meaning units in common group themes.

Themes: Group	**BW Count**	**SI Count**
Collaboration	17	5
Cohesion	7	3
Teambuilding	17	5
Prevents Group Challenges	8	1
Equal Opportunity	18	1
Combines/Betters Ideas	17	2
Overlooked Perspectives	1	5

The most common group-focused themes are:

- Collaboration – Many students identified the ability to collaborate with their team as one of the benefits of both methods. Commonly, responses also included the ability to collaborate without judgement. Examples include "as a group we collaborated together to come up with ideas to approach our project" (091-BW); "allowed for quick collaboration without any judgement or fixation onto a single idea" (146-BW); "helps teams collaborate more effectively" (069-SI); and "you are actively discussing ideas with your team" (143-SI).
- Cohesion – While coming to a group consensus is part of the collaborative process, many students mentioned the coming together, agreeing on ideas, and general cohesion of the team. Therefore, this theme is separated from collaboration as a whole. Examples include "(opportunity to) converge on ideas" (083-BW); "team can get together to discuss what each individual thinks about a lot of ideas and combine their reasoning to find the optimal

solution" (064-BW); "got to talk over every idea and decision together as a team" (074-SI); and "allows adjustment to a question ... but narrows focus towards a shared vision" (148-SI).

- Teambuilding – The concept of teambuilding and general group work were other common benefits for students. This is more focused on coming together as a team rather than the discussion or consensus on a particular topic. Examples include "feel...brings out the best in the team" (009-BW); "opportunity to come together as a team" (083-BW); "believe...helped with team building" (005-SI); and "is a group work thing" (055-SI).
- Prevents group challenges – Another common theme is that utilizing these methods helped mitigate common group challenges such as groupthink and limiting beliefs. This was mostly seen in BW, while by contrast, only one meaning unit in SI was related to eliminating common group challenges. Examples include "[prevented] limiting ourselves to something perfect" (065-BW); "prevents groupthink" (006-BW); and "believe...ability to eliminate tunnel vision that groups experience on a project" (146-SI).
- Equal opportunity – Having the ability for all members of a team to contribute is a common challenge in team dynamics, particularly as teams become larger. Participants noted that members were able to all be included in the discussion and felt like they were able to express their ideas more freely. This is particularly the case in BW where 18 units mentioned this as a benefit. However, in SI, only one meaning unit references this theme. Examples include "each team member can have a say in the process" (021-BW); "(allows everyone to contribute) without being overshadowed by louder voices" (040-BW); and "makes the ideation process more inclusive" (040-SI).
- Combination of ideas – Participants also saw group benefits in the ability to combine or bounce ideas off of each other. Examples include "feel...most effectively combines the ideas of multiple people" (009-BW); "I find that ... everyone can contribute a little to each idea and shape it up into something more tangible" (149-BW);" can breed new ideas as you and a group see what you all come up with" (094-SI); and "allows (the team) to create new ideas" (141-SI).
- Overlooked perspectives – The responses had some benefits that noted that the group was able to see overlooked perspectives and was able to express ideas to different people. Examples include "(helped us) see the perspectives ... overlooked" (083-BW); "[team] see how...express the same idea in different ways to reach different people" (038-SI); and "allow[s] the team using it to pick different perspectives that fit different disciplines/areas of the scope of the project" (075-SI).

Other topics noted included the groupwork being a more creative process (e.g. "makes the group work more creative" (019-BW)), the ability to have simultaneous idea generation (e.g. "allows everyone to contribute ideas simultaneously" (040-BW); "allows the entire team to collaborate at the same time" (002-SI)) and improving group concentration (e.g. "(shortness) makes the entire team wholeheartedly concentrate" (060-BW)).

Task. A *task benefit* was anything that benefited the outcome of the idea generation process, such as quantity of ideas and quality of ideas among others. Table IV shows common themes that were identified in the task benefits with counts of how many times that theme appeared.

Table IV. Count of meaning units in common task themes

Theme: Task	**BW Count**	**SI Count**
Quantity	24	3
Efficiency	30	7
Quality	31	35
Wide	6	10
Iteration	19	3
Perfection	11	-
Natural development	3	10

The most common task-associated include:

- Quantity – The number of tasks that were generated was a heavily noted benefit primarily for BW. Examples include “helps generate a larger pool of diverse concepts quickly” (040-BW); “enhanced the number of ideas my team could output” (065-BW); “very quick way to get ~25 ideas you can build off of” (062-SI); and “gives me more ideas by changing the question” (076-SI).
- Efficiency – Related to the quantity of tasks is the efficiency of idea generation. This is treated as a separate theme as generating ideas quickly might lead to generating more ideas, but it is not guaranteed. In addition, efficiency also includes less repetitive idea generation. Many participants noted the time pressure as a reason for the efficiency of these methods. Examples include “time pressure...required us to use a lot of our brain power to generate the ideas more... efficiently” (087-BW); “how fast you can come up with ideas” (129-BW); “can generate first few ideas simply without any effort” (055-SI); and “make concept generation less repetitive” (028-SI).
- Quality – Participants also commonly noted that the quality of ideas was perceived as better. This includes things such as more creative ideas, multifaceted ideas, diverse ideas, richer ideas, stronger ideas, etc. Examples include “enhances both the variety and quality of the ideas produced” (123-BW); “fosters a more creative and multifaceted pool of solutions” (001-BW); “(help[s]) unlock innovative solutions that may not have been considered” (001-SI); and “[re-examining the problem] often sparks unexpected solutions” (117-SI).
- Wide – The use of wide was common enough to develop a separate theme. From participant responses, it was difficult to determine if the term “wide” was a larger quantity of ideas or more creative ideas. Therefore, these meaning units were not included in either of those themes. Examples include “believe ... is able to help generate a wider idea set” (004-BW); “showed a broad way of how quickly a group of people can generate a wide variety of ideas” (073-BW); “can still be used ... [for] thinking of all possible ways a prompt can be presented

(to ensure...cover all the possible bases)" (014-SI); and "suppose...allows for a wider variety of ideas to be generated" (002-SI).

- Iteration – Another common theme was the iteration or refinement of ideas. Responses from BW discussed the ability to add to or improve ideas. This theme was much less common with SI with some of the meaning units being related to the building of ideas. Examples include "give chance to mix or improve ideas" (028-BW); "lets you refine many ideas to pick from a good selection" (112-BW); "can... highlight missing components" (047-SI); and "new questions can then serve as starting points for idea generation" (070-SI).
- Perfection – The concept of perfection or optimal idea was identified in BW. This is a subset of iteration, but rather than the incremental improvements, this is creating the best idea, a more final idea, or the optimal idea. In BW, this theme was identified in 11 units. No meaning units from SI included this same theme. Examples include "ultimately helps create one idea that incorporates everyone's" (127-BW); and "the best idea has a better chance of cropping up" (034-BW).
- Natural development – The flow, natural development, or connections of ideas and concepts were mentioned. This includes aspects such as clarification of ideas and alternative approaches. While these units seemed to lead towards more creative or higher quality ideas, it was not explicitly mentioned. Examples include "encouraging a steady flow of diverse ideas from multiple perspectives" (117-BW); "(three options) allows for ideas to develop naturally" (044-BW); "can trigger new ideas from rewording the problem" (085-SI); and "allows us to generate concepts that we might not have thought of in a straightforward way" (018-SI).

Discussion

Overall, the findings indicate a clear divergence in participant experiences between BW and SI, both in perceived quality of experience and in the nature of reported benefits. Experiences associated with BW were overwhelmingly positive, with consistently high experience scores and minimal negative sentiment, suggesting a broadly favorable and shared perception of BW across participants. In contrast, experiences with SI were more mixed. While moderately positive overall, SI elicited a higher-than-expected proportion of neutral and negative experiences, indicating greater variability in how participants engaged with and perceived this approach. This divergence was further reflected in the coding process, as BW experiences showed greater consensus among coders compared to SI, suggesting clearer, more uniformly interpreted experiences.

Thematic analysis also revealed meaning differences in perceived benefits: SI benefits were primarily individual-focused, with lesser task- or group-level impact, whereas BW benefits were distributed more evenly across individual, task, and group domains. Together, these patterns suggest that BW may foster more shared, cohesive, and multi-level benefits, while SI appears to produce more individualized and variable outcomes. The following discussion explores these themes in greater depth, situating them within existing literature and considering their implications for practice and future research.

Consensus and Experience. The members of the research team reached a consensus on 88% of the experience ratings for BW, due to the fact that students more clearly expressed their thoughts, using definitive statements as opposed to phrases like “I guess” or describing their experience simply as "interesting" which was more frequently seen in SI responses. Based on the distribution of ratings for student experience with BW, most students had a positive experience with BW, and considerably few percentages of students had a negative experience. In total, ~82% of units were positive/relatively positive, ~4.5% were negative/relatively negative, and the remaining ~13% were neutral, and the overall experiences that students reported for BW pertaining to the workshop can be interpreted as positive.

The overwhelmingly positive experiences associated with BW, coupled with the high level of agreement among coders, suggest that BW may provide a more structured and consistently interpreted experience for participants. This consistency is significant because it indicates that participants not only experienced BW favorably but also described their experiences in ways that were broadly shared and easily identifiable. Such clarity may enhance reliability in both implementation and evaluation, making BW more predictable and potentially easier to scale or replicate across contexts. In contrast, the greater variability observed in SI experiences suggests that participants may engage with SI in more divergent ways, which can complicate both outcome assessment and practical application.

For SI, the team members reached a consensus on ~ 63%, due to more ambiguous responses from the students. Most disinterest in SI seemed to stem from the lack of practical and applicable ideas produced, and difficulty understanding the instructions and task. When it comes to the breakdown of SI experience, ~52% were positive/relatively positive, ~29% were negative/relatively negative, and the remaining ~18% were neutral, displaying that most students reported a positive experience for SI, although this percentage is far less significant than that for BW. Nearly a third of students had a negative/relatively negative experience with SI, which is far greater than the ~4.5% that was negative for BW, which was unexpected.

The presence of a greater-than-anticipated proportion of neutral and negative experiences within SI is noteworthy, and this variability may reflect differences in participant expectations, levels of support, or contextual factors influencing implementation. From a practical standpoint, this suggests that SI may require more deliberate scaffolding, facilitation, or participant preparation to ensure more consistently positive experiences. For researchers and practitioners, the lower consensus in coding SI experiences further underscores the need for clearer frameworks or guidelines to reduce ambiguity and improve shared understanding of what constitutes successful SI engagement.

Breakdown of Benefits. Note that around 50% of BW benefit meaning units were attributed to individuals, ~24% to task, and ~21% to the team, with the rest being miscellaneous.

For individual benefits, students most reported their ability to work without being judged and better understand their teammates' perspectives, and common group benefits included reports of collaboration, team building, democratization of the ideation process, and ability to combine ideas. For task benefits, the most commonly occurring themes were the creation of more diverse and richer concepts, along with the efficiency of BW with regards to the quantity and speed of ideas being produced. These findings align with existing literature that students need a supportive and safe environment to share their ideas without the fear of being judged [5], [6]. Fear of judgement may also be considered an emotional block which can limit a student's creativity, as supported by existing literature [22]. The lack of judgement due to the silent nature of BW may have enhanced feelings of collaboration and encouraged team building by removing emotional or cultural blocks, and ultimately led to more creative, plentiful, and efficient ideas.

The task benefit of creating many ideas as mentioned by many students can also be connected to the line of existing literature that suggests generating a lot of ideas and entertaining a wider scope leads to better ideas [11], [12], or that more surprising and revolutionary ideas can be generated when more ideas are generated, and a broader scope is adopted [13], [14]. The larger pool of ideas does not guarantee that the ideas will be novel, however now that a general understanding of student experiences as they apply to the specific in-class prompt has been established and revealed a general consensus that BW allowed for the development of novel ideas, further research can be conducted analyzing student responses to the prompt and which tool they are more likely to use for their real-life projects.

For SI, the main individual benefits that students experienced were being able to identify overlooked factors and expand the scope of the problem which could then in turn allow for the generation of new and novel ideas. Since SI did not directly allow for the generation of many creative ideas, but rather provided a tool to expand perspectives, far more SI benefit meaning units were attributed to the individual, (~73%), and less to the task (~17%). Those benefits that were attributed to the task were mostly due to the creative and multifaceted approach that SI provided for analyzing the given prompt.

Common themes seen within group benefits for SI include team building as students were able to verbally discuss with their groups, however some related limitations to that were the classroom being loud and the team being split into two rows, so it was hard for members to hear each other. Splitting groups into smaller ones and ensuring there are no environmental/physical blocks may improve student experiences with SI. Also, in contrast to the silent nature of BW that allows all members to contribute equally, students reported that during the SI activity, certain team members dominated the conversation. These factors may have restricted the collaborative aspect of SI, as group benefit meaning units made up only ~6% of total benefit meaning units for SI.

Differences in how benefits were distributed across individual, task, and group levels have important implications for practice. SI's tendency to yield primarily individual-level benefits suggests that its impact may be more introspective or personally oriented, which can be valuable in contexts emphasizing individual growth or reflection. However, the limited group-level benefits raise questions about SI's effectiveness in fostering collaboration or shared task outcomes. In contrast, BW's more balanced distribution of benefits across individual, task, and group domains suggests a broader scope of influence, potentially supporting both personal development and collective functioning.

Limitations

Brain Writing v. Brain Walking Labeling. Although the in-class exercise followed Brain Writing procedures, the instructional presentation labeled the activity as "Brain Walking." Consequently, some survey responses refer to "Brain Walking" even when describing Brain Writing experiences. For the purposes of this study, this inconsistency did not impact the students' experience with the Brain Writing exercise. However, for future studies workshop materials should be revised to read "Brain Writing" instead of "Brain Walking".

Group Size. Most literature evaluates small teams (often two to three students) and noted larger groups (over six students) showed reduced novelty outcomes due to lower quality input when using ideation methods [14]. In this study, students worked in groups of six to seven undergraduate and graduate participants drawn from different majors. This group size and disciplinary diversity may have contributed to students' reports that the final outputs of SI and BW contained fewer "usable ideas." Future studies continuing comparisons of BW and SI should want to address and test the group size as an independent variable and examine its relationship to both perceived experience and idea outcomes.

Coding Bias. The qualitative data from this case study were self-reported by the students after the activity, meaning the dataset reflected what students reported they had experienced versus what may have happened. As a result, researchers coded what students reported experiencing, which may differ from what occurred in real time due to recall bias or differences in how students interpreted the survey prompts. In addition, students were asked to reflect on their experience with BW first, and then SI second. This led to frequent comparisons between the two methods in their response to SI (e.g., stating they "preferred brain walking"), which also led to difficulties interpreting and isolating perceptions specific to SI. Future studies should consider counterbalancing the method of order, such as having half the teams start with SI and the other half start with Brain Walking, recording their experiences after completing each activity.

Student Attendance. Two students reported absent on the day of the workshop. One student included a statement of their absence (due to sickness) in their survey response and admitted to reading the presentation slideshow from home to respond to the survey. However, the researchers were unable to identify the second student who was not in attendance.

Concluding Remarks and Future Research Directions

To develop idea generation skills of engineering students, an idea generation workshop was designed and delivered during the first semester of a two-semester multidisciplinary project course sequence in the college of engineering in a large state university. The workshop was delivered during the regular class meeting time for the course and lasted 75 minutes. Work completed by the student teams was collected at the end of the workshop. Also, after the workshop, an anonymous survey was distributed that invited students to respond to a set of reflection prompts to describe their experience and share their opinions about these two ideation processes. Data for this study was collected in the Fall 2025 semester when 151 students were enrolled in the course.

Preliminary findings indicate that students had primarily positive experiences with the presented idea generation methods with ~82% of participants finding BW to be positive/relatively positive and ~63% of participants finding SI to be positive/relatively positive. Preliminary findings also indicate that SI primarily yielded individual benefits while BW had more group and task benefits in comparison. Overall, the majority of students indicated a better experience with BW as opposed to SI.

A limitation of the study is the lack of a direct assessment of team idea generation. That is, although the students may say that the idea generation workshop helped them improve their idea generation skills, it is not clear if this perceived improvement would also be reflected in the quantity and the quality of the ideas they generate for their projects. However, due to non-disclosure agreements with the project sponsors, the research team was unable to study and assess the quality of the ideas generated by the teams. However, the ongoing analysis of the responses to another prompt in the anonymous survey will reveal insights into (i) which idea generation technique each team chose to use for their own project and (ii) what perceived benefits are reported by the students based on that experience during the last work element of the workshop.

Future studies should examine how students apply BW and SI beyond the structured context of the workshop by analyzing which tools they voluntarily select for their independent or course-based projects. Investigating tool choice in authentic project settings would provide insight into how perceived experience, usability, and benefit distribution influence real-world adoption of these ideation methods. Such work could help determine whether the more positive and multi-level benefits associated with BW translate into long-term preference, or whether SI's individual-focused benefits make it more appealing in self-directed contexts. Additionally, examining how tool selection aligns with project type, collaboration demands, or individual learning goals may further clarify the conditions under which each approach is most effective. Extending analysis beyond the workshop environment would therefore strengthen understanding of how these tools function in practice and inform more intentional integration into future instructional or professional settings.

Acknowledgements

This work is supported by the United States National Science Foundation under Grant No. MCA 2219012. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation. Elif Akçalı is also supported by The Michael Durham Professor in Creativity in the Engineering Innovation Institute in the Herbert Wertheim College of Engineering at the University of Florida.

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Appendix A: Workshop Handouts

A.1. Workshop Rules: Four rules for today...and life in general

No	Rule	Quote, Individual, Profession
1	Be playful and rebellious	“Humanity has advanced, when it has advanced, not because it has been sober, responsible, and cautious, but because it has been playful, rebellious, and immature.” Tom Robbins, Author
2	Defer judgement	“The ability to observe without evaluating is the highest form of intelligence.” Jiddu Krishnamurti, Philosopher
3	Be curious	“Curiosity is one of the most permanent and certain characteristics of a vigorous intellect.” Samuel Johnson, Author
4	Do the work	“Nothing ever comes to one, that is worth having, except as a result of hard work.” Booker T. Washington, Educator

A.2. Warm-Up: Your Experience

What happened?

- “How was I supposed to come up with responses?”
- “I felt pressured by the deadline."
- “I could not write fast enough.”
- “I was not sure how much I wanted to get into this exercise.”

A.3 Brain Walking: Example: What is it?

Prompt: How can we sell more via our on-line store?
Potential Ideas:

1. We can ship for free.
2. We can increase our internet presence.
3. We can put more offerings, teasers, interactive ads, and must read content for as many appropriate channels as possible.
4. Another idea
5. Another idea
6. Another idea

A.4 Brain Walking: Process Overview

- I will provide a prompt.
- Write an idea or a potential solution on the top of the sheet legibly. You have 2 minutes.
- Pass the sheet to the person on your right.
- Write another idea or a potential solution
    - Add a different idea
    - Improve one of the existing ones
    - Combine some of the existing ones into a new one

A.5. Worksheet: Brain Walking

Brain Walking

Team:___________________

Name:____

- Consider the prompt question and write an idea or a potential solution. You have three options:
    - Add a different idea
    - Improve one of the existing ideas
    - Combine some of the existing ideas into a new one
- You have 1.5 minutes
- When the time is called, pass the sheet to your teammate on your right

No.	Idea
1	
2	
3	
4	
5	
6	

A.6 Semantic Intuition: Example: What is it?

Prompt: How can we sell more via our on-line store?

1. What is the most important noun in the question above?
2. What is the most important verb in the question above?
3. Create a list of synonyms, related words, and antonyms for the noun
4. Create a list of synonyms, related words, and antonyms for the verb
5. Pick a noun from the expanded list for the noun and a verb from the expanded list for the verb and use those to generate an idea.

A.7 Semantic Intuition: Process Overview

Question: How might we individualize and improve engineering education effectively?

- Pick the most important noun and verb
- Generate a list of synonyms, related words, and antonyms for the noun. You have 2 minutes.
- Generate a list of synonyms, related words, and antonyms for the verb. You have 2 minutes.
- Generate ideas by picking a random noun-verb pair from the lists you produced. You have 6 minutes.

A.8. Semantic Intuition: Worksheet 1

Semantic Intuition 1

Team:______________________________

Step 0: Consider the following research question.

How might we individualize and improve engineering education effectively?

Step 1: Circle the most important verb in the research question above. Circle the most important noun in the question above. Come up with alternatives for this verb and this noun.

Alternatives	**Selected Verb:_______________**	**Selected Noun:______________**
1		
2		
3		
4		
5		

Step 2: Pick an alternative verb and alternative noun combinations and create alternative research questions.

No.	**Question**
1	
2	
3	
4	
5	
6	

A.9. Semantic Intuition: Worksheet 2

Semantic Intuition 2

Team:______________________________

Step 0: Write a research question or a problem statement related to your project that relates to your team charter.

Step 1: Circle the most important verb in the research question or problem statement above above. Circle the most important non in the research question or problem statement above. Come up with alternatives for this verb and this noun.

Alternatives	Selected Verb:_______________	Selected Noun:______________
1		
2		
3		
4		
5		

Step 2: Pick an alternative verb and alternative noun combination and create alternative research questions or problem statements to respond.

No.	Question
1	
2	
3	
4	
5	
6	

Appendix B. Sample Student Work

B.1 Brain Walking

One of the teams with 7 students generated the following ideas:

Sheet	No	Idea	Author
1	1	Pair students into groups of 2, and have students responsible for ensuring their partner understands an idea	1
	2	Make the content more digestable – be clear about deadlines, readings, and homework due, make the homework related to the class learning and do examples in class	2
	3	Post tons of practice problems with solutions so students have a good number of problems for the particular topics they struggle with	3
	4	Give 10 students the guaranteed opportunity to work for their dream company if they fulfill rigorous requirements and they will become genius and motivated to learn real fast under pressure	4
	5	Assignments that force student's to assume a teaching role to show their understanding of a topic. Teaching is the best way to learn.	5
	6	Encourage students to step into a teacher/TA role for extra credit and potential improvements in the class.	6

Sheet	No	Idea	Author
2	1	Open up to more types of engineering disciplines to suit the more niche/individualized passions of more people + provide intro workshops for those undecided to learn more/explore.	7
	2	Have open ended classes where students get to choose topic for their passionate to study	1
	3	Make class more engaging – professors make jokes, give real like examples, and call on students to answer questions. Have in-class assignments that encourage students to pay attention	2
	4	More electives and special topic classes so students are interested and focus more	3
	5	Make students work in an interdisciplinary team like {course} every single year of college. Doesn't have to be as intense, but the focus is a team similar to this and a goal.	4
	6	Give options for student's to exercise their creativity on final projects more often. Student's will still have to meet certain guidelines.	5

Sheet	No	Idea	Author
3	1	Include – requirement for a certificate/engineering education (innovation/PM [Project Management]/leadership) as part of degree, so students graduate with their degree and niche skills from eng.	6
	2	Add a practical element to the certificate/make a workshop of their ???? Subject and teach/present as a final project	7
	3	Have various classes where they can earn the same certificates, so they can customize their education by choosing the class they want	1
	4	Make classes more hands on – get engineering parts and materials for students to hold so they can better visualize engineering concepts discussed in class.	2
	5	More emphasis on relating concepts learned in class to actual applications discuss assumptions in model, whey they’re there, and how they differ from industry	3
	6	Make students give speeches in front of a crowd everyday until they become so good communication and preparing they can collaborate with anyone	4

Sheet	No	Idea	Author
4	1	Focus more on applied skills like courses structured around labs.	5
	2 (1)	Focus on relevant applied skills in industry and research (softwares, tools, languages, skills, etc.) in classes that students can learn.	6
	3	Add industry personnel to classes to provide insight on the daily goings of those in their desired area of study and be real/passionate.	7
	4	Have students work with industry people on-site while being guided by a mentor	1
	5	Add more physicality to class – require students to get up and move after long periods of sitting. Also account for visual learners with photos and videos	2
	6	Focus more on industry software and simulations instead of just doing theory. Spend less time on overly simple models.	3

Sheet	No	Idea	Author
5	1	Give a team of middle schoolers to the trainee. Make the trainee figure out how to control this team and their antics to finish building a Lego set with a minimum of 15-days to complete.	4
	2	Make research within the department a mandatory requirement during the student’s degree.	5
	3 (1+2)	Encourage research of engineering ed. topics like leadership, project mgmt., etc in degrees	6
	4	Read other papers on best teaching habits/ apply to yourself or others in a real world setting	7
	5	Make students teach the concepts their learning about to a general audience so that what they learn is reinforced	1
	6	Create a more competitive atmosphere in the class where students can safely show off their knowledge with games that are not graded. Have tournaments	2

Sheet	No	Idea	Author
6	1	Interactive physics simulators that use equations learned in class. Uses visualizations to give an intuitive understanding.	3
	2	Require students to manage a tier-5 civilization in an improved version of cities skylines for a grade	4
	3	During lectures incorporate a visual or tangible demonstration to help students visualize better	5
	4 (all)	Incorporating applied experiences like physics simulators of city skyline planning as part of the curriculum in engineering degrees	6
	5	More exploratory/open-ended simulations that can have their parameters tweaked by the user/student to understand causals/chains	7
	6	Make students predict things and then test them in real world conditions to see if their predictions hold	1

Sheet	No	Idea	Author
7	1	Make the classes smaller – more one on one interactions between the student and professor, more group interaction, makes class feel more personal and less transactional.	2
	2	Could add discussion sections like in Calc 1-2 for extra practice and an opportunity to ask questions	3
	3	Make students "Brain Walk" for an hour straight everyday and give personalized feedback by AI until they are an idea machine	4
	4	Give more freedom to TA's to lead a collaborative discussion with student's and provide their own perspective	5
	5	Encourage more 1:1 experiences with professors, TAs,	6
	6	Open more office hours into a cutting edge research to show the frontier/to get excited of the future but first needing the background	7

B.2 Semantic Intuition

Semantic Intuition 1

Team:__07________________________

Step 0: Consider the following research question.
How might we individualize and improve engineering education effectively?
Step 1: Circle the most important verb in the research question above. Circle the most important noun in the question above. Come up with alternatives for this verb and this noun.

Alternatives	**Selected Verb:__individualize__**	**Selected Noun:__education___**
1	generalize	learning
2	tailor	training
3	accommodate	Knowledge transfer
4	cater	brainrot
5	uniquify	schooling
	specialize	enlightenment
	personalize	

Step 2: Pick an alternative verb and alternative noun combinations and create alternative research questions.

No.	**Question**
1	How can we personalize learning for the three learning types?
2	How can we tailor brainrot to students?
3	
4	
5	
6	