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Creating a Reflective Framework for Exploring Divergent Thinking Potential to Enhance Unconventional Ideas

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Abstract: This paper aims to investigate the implications of divergent thinking (DT) on the 'Habit-Bound Thinking' of undergraduate design students. The goal of this research is to find a way to develop creative designs that accurately mimic 2D frequent shapes. The results of this semi-experimental study gathered and analyzed observational data to evaluate the participants' divergent thinking abilities to generate a wide range of ideas or solutions to a given situation. Two colleges' worth of 120 students were split evenly between the control and experimental groups. This data set addressed the study's primary research question and produced substantial changes in the outcomes.

Students in the control group improved significantly on tests measuring component knowledge and creative ability after receiving training and creating the graphical models. These results back up the theory that student creativity is fostered via project-based learning. The establishment of workshops led to a rise in originality.

Keywords: Divergent Thinking, Creativity, Control, Experiment, Visual-Communication.

1 Introduction

Thinking strategies have been used in numerous studies due to their significance and effectiveness in generating new ideas [1]. Unlike convergence, which requires a single, well-defined path, DT encourages an open, impromptu mode of thought that can go in any number of directions. Because of this, it is said to inspire originality in the pursuit of answers.
Despite the considerable significance attributed to novelty in the conceptualization of creativity [2]', [3], [4], [5] there remains a substantial amount of controversy and debate surrounding its precise definition, particularly about its role in fostering innovation and driving transformative transformations. While acknowledging creativity as a multifaceted phenomenon, it is crucial to highlight the significance of individuals and their surroundings in fostering creative aptitude. This can be observed through various means such as assessments, narrative construction, interviews, or experimental approaches [6]. However, it is worth noting that several design schools administer acceptance examinations that assess applicants' overall drawing abilities, proficiency in specific techniques, and ability to categorize designs, all of which are evaluated using a credit system.

Educating students to think creatively ought to comprise the primary goal of design programs, but other studies have instead concentrated on how ideas are generated and classified in terms of their effectiveness in influencing student behavior and outlook [7] To increase the likelihood of coming up with new and useful ideas, it helps to keep an open mind and a pliable frame of mind. The ability to think outside the box is often gauged by administering a divergent thinking test. The goal up until now has been to quantify this potential in individuals using just one or two tests; however, this may have hampered our capacity to generalize the outcomes of the studies because the tests were not comparable. Furthermore, it found that some divergent thinking tests were superior to others in terms of their capacity to generate more genuine responses.
The evaluation system utilized in numerous conventional design departments is a subject of controversy when it comes to identifying and assessing creativity. Due to this factor, the apprehension associated with committing errors or falling short of perfection and facing criticism has the potential to impede the innate creativity inherent in individuals.
This research focuses on the significance of behavioral characteristics that enhance technical skills and raises the question of the factors that contribute to an individual's creativity. As a result, it is suggested that Design schools should implement a systematic method in conducting interviews with prospective students, beyond the traditional evaluation system that largely focuses on the enhancement of technical abilities. The inclusion of clearly defined standards would support educational institutions in making well-informed assessments, enabling them to adequately cater to potential students in the coming years. The research utilizes a quantitative approach, incorporating a diverse set of skills and demographic variables to build and enhance these ideals.

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2 Theoretical Background

One of the aspects upon which researchers have been focusing is individual potential, as in developing the potential for solving problems, making decisions, and making evaluations [8]. However, this paper questions whether certain aspects of a personality constitute an individual's ability to be creative [2], [9] it is sometimes hard to determine the extent to which a person has this quality.

Some researchers, such as the psychologist Mihaly Csikszentmihaly [10], saw creativity as an integral process and listed some features of a creative person such as love, enjoyment, and willingness to take risks in what he/she does. He further suggested that learning was the product of interaction between an individual's thoughts and the sociocultural context.

Stein in 1974 also set out some common elements of a creative person such as curiosity, preoccupation, and showing unconventional tendencies. A major part of the investigation agreed with Flexibility Fidelity and Originality [11], [12].The National Advisory Community on Creativity and Culture suggested that teaching was started to encourage students to make them believe in their potential [13]. Feldman, et al. [14] suggested that to be creative in the field of education at the early stages, children should be encouraged to believe that they can change the world [15]

Creativity should be the central aim of design education; however, some researchers have focused on the process of producing ideas and assessing their classifications in terms of their inability to change behavior and attitudes [16]. It is important to be open-minded and to have flexible attitudes to maximize the possibilities of generating ideas. Divergent thinking tests are among the most frequently used to measure creative potential. Until now, the aim has been to measure this potential in individuals based on one or two specific tests; this, however, may have affected the ability to generalize the results of the studies, as the tests were not equivalent (like for like). In addition, some divergent thinking tests appeared to be better than others in terms of their ability to produce more authentic responses.

The analogical comparative [17] demanded imagination training and the use of metaphors to create innovative products. Intuitive thoughts help designers to establish uncommon relationships in variable situations. Learning in a creative environment does require support and encouragement from home/school, according to Batey Furnham [18] who published the 5-factor model of personality to measure creativity namely openness to experience, conscientiousness, extraversion, agreeableness, and neuroticism.

Creative thinking is characterized by Divergence and Complexity because it contains entangled cognitive, emotional, and ethical elements that constitute a unique state of mind, and researchers have used various expressions (such as 'openness'), that correspond to the concept of "creative thinking" and summarized it from a procedural point of view.

This provides an optional ability to generate a few variables from previously learned information, experiences, or concepts, leading to an 'openness' estimate of the potential for creative thinking, [19].

Many researchers extensively investigated [20] open-ended questions, as one of the most common ways that allow designers to produce numerous ideas based on fluency: there were three components

How many ideas

Flexibility (referring to the types of ideas)

Originality (referring to unique ideas) [11], [16]

According to the dual pathway model of creativity [7] where prolonged efforts will produce a higher number of ideas in a range of accessible solutions, based on [21] divergent thinking leads to the ability to analyze and synthesize open thinking and imagination.

3 Related Work

In graphic communication subjects such as planning a design, students are taught to follow a process: requirements such as brainstorming, sketching, production processes, and refinement all support convergent thinking, with the focus on 'evaluating' based on ideas or solutions, without quality.

A study was conducted by Carbonell-Carrera, C., et al. [22] based on the 3D CAD graphic modeling activities of seventy-two engineering students. At La Laguna University as part of the Degree in agricultural engineering and rural areas, open activities were conducted with computer-aided design, and the participants needed to build a three-dimensional volume starting from a two-dimensional shape and arriving at four different three-dimensional design solutions. The results showed that the students felt less conditioned to follow predetermined paths and this improvement obtained a high value of 4.19. They also increased their ability to take risks (a value of 2.94). Their use of color and perspective also improved (5.93) and finally, their overall graphics skill increased to 5.59.

Another study was applied to experiment with the relationship between the degree of creativity and the quality of the design solutions, looking at the relationship between feasibility and effectiveness and the values for novelty, usefulness, and creativity [23]. At the University of Jaume, in Spain, four teams consisting of a designer and engineer were asked to draw a drawing table that occupied as little space as possible, using intuitive methods in creative thinking techniques. The four

methods used were BR1, BR2, Functional Analysis, and Scamper. The degree of creativity was measured by assessing the degree of novelty and usefulness of the solutions for generating ideas.
This paper attempts to develop a particular procedure that could embrace the personality of students instead of focusing on thinking skills, across the basics of creativity thriving on uncertainty.
Considering the above conditions, this paper seeks to promote creative thinking by generating ideas in open activities validated by six skills fluency, flexibility, novelty, assumptions, and observation of important factors for firm innovation. One hundred randomly selected design students for this study, to guide the training of students toward innovation in communication design.

4 Materials & Methods

The current investigation aimed at studying the contribution that creativity makes to personal performance, within a classical learning climate. It provides a tool to collect descriptive data from the groups that would enhance students' ability to think divergently. It was based on a framework [11], [16]which is considered the most common method for measuring creativity, flexibility, fluidity, processing, and originality (TTCT Torrance Tests of Creative Thinking, Torrance [24].
Two workshops were proposed.
Workshop 1: Aimed at collecting descriptive data from the groups to find multiple solutions to the problem posed due to divergent thinking.
Workshop 2: Aimed at re-designing the students' ways of thinking in the experiment group.

4-1 Study Sample

The research examined data from one hundred and twenty visual communication students, made up of sixty-two males and fifty-eight females, in the 19-24 age group. They were from two different universities, both having a Control group and an Experiment group, located in different areas for the basis of comparison. The students were informed at the outset about its objectives and its confidentiality.
Although most students were familiar with brainstorming activities and could feel free to express and make connections to their ideas, the researchers used a Likert Scale, Table (1.5). Students were first asked to freely write a word to express a round figure; this resulted in answers such as a wheel, the sun, a full moon, a bike wheel, and an orange fruit some samples were included in this paper see figure (2.5).
The second and third questions asked for the shapes to be divided. The resulting shapes were limited and rigid and were mostly repeated.
In the second stage, the researcher specifically asked what shapes could be extracted from one shape, and how the resulting shapes could be arranged in different groups. The students were also asked to apply a color theory to their pattern of shapes. Table (2.5) shows the two groups of questions that were asked in the workshop.

Table 1 *Relief Interpretation Survey*

Question (1–5 Likert Scale: 1 Strongly Disagree. 5 Strongly Agree) Results	Mean (SD)
I consider myself to be creative.	3.9 (0.98)
As a future graphic designer, I consider it important to strive to be unique in my creative endeavors.	4.6 (1.08)
I believe that exercises can influence my creativity.	4.3 (0.74)
I think the SCAMPER technique is valid for developing my creativity.	3.7 (0.88)
I think that in graphic design it is necessary to consider several solutions for the same problem.	4.1 (0.94)
I think that creative people are needed in today's graphic projects.	4.8 (0.79)

SD: Standard Deviation

Table 2 *Study Variables of the Two Groups (Control and Experiment)*

Variables	Experiment group (Divergent questions)	Control group (Convergent questions)
Level of	Express a round figure	What a round figure looks like.

Legibility		
Level of Flexibility	Divide the figure into pieces.	Divide the figure into your thought pieces.
Level of Shape Symmetry	What shapes can be extracted from the figure?	Arrange the resulting shapes into different groups.
Level of color scheme harmony. (Color Theory Reference)	Propose colors for the concluded shapes.	Apply the color wheel to the groups.

The convergent
test for evaluating creativity scores of the Control Group ranges from 0% to 100% average since each of the four figures can receive a quantitative score of 0 to 25 (converted to a percentage) points. Table (3.5) shows the creativity results for the Control Group.

Table 3 *Control Group (Convergent Test)*

Variables	1st University (Control)		P value
	Pre-test	Post-test	
Level of Legibility	72%	67.4%	0.03*
Level of flexibility	60.6%	65.8%	0.14
Level of Shape Symmetry	73.7%	76%	0.43
Level of Color scheme harmony (Color Theory Reference)	79.3%	77.3%	0.51
Average	71%	72%	0.66

The divergent test for evaluating the creativity scores of the Experiment Group ranges from 0% to 100% average since each of the four figures can receive a quantitative score of 0 to 25 (converted to a percentage) points. Table (4.5). shows the creativity results for the Experiment Group.

Table 4 *Experiment Group (Divergent Test)*

Variables	2nd University (Experiment)		P value
	Pre-test	Post-test	
Level of Legibility	72%	89.4%	0.01*
Level of Flexibility	67.6%	79.8%	0.00*
Level of Shape Symmetry	71.5%	78%	0.03*

Level of Color Scheme Harmony (Color Theory Reference)	78.8%	92%	0.00*
Average	72%	85%	0.00*

A workshop has been conducted after the pre-test.

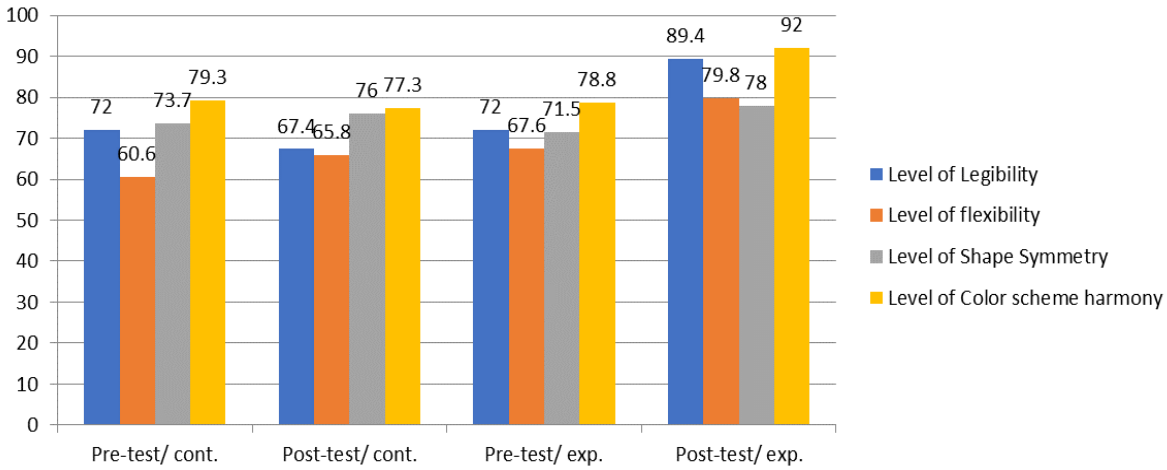

Fig.1. Results of the Workshops

5. Results of the Workshops

Each hand-sketched print in this research has been viewed as a symbol that transmits significance. A text is simultaneously an intricate sign and a collection of signs. The produced conceptions are signified in all of the drawings, while the signifiers are the many associations established by the participants to visually depict this metaphor. Figure (1) depicts the classification of signifiers used by the participants in the two groups.
. The participants' creative flexibility in terms of the variety of ideas they produced was compared across the two groups, with the results supporting the hypothesis that those asked open questions would employ a wider variety of signifiers to convey the meaning of the signified, circle than those concrete questions -based workshops. As shown in Figure (1) different categories of signifiers were generated by the experimental group, with the control group sharing less of these. In terms of similarities. In terms of shape symmetry, the experimental group generated more kinds of shapes than the control group. The control group, in contrast, employed the harmony more often, , than the experimental group. In the following discussion section, the author analyses some of the results to illustrate the findings.

6. Results and Discussion

According to the literature referenced above [11], [16], the range of divergent thinking was usually measured according to the number of responses and the degree of flexibility, related to the variety of responses given, i.e., the number of deconstructed ideas and the number of different categories used to evaluate the originality of responses according to both workshop variables shown in figure (1.5) above, the results were characterized by an obvious harmony, continuity, or symmetry. Consequently, comparable with the results of previously referenced research Carbonell-Carrera, C, et al. [21], it is important that creative thinking should be incorporated into the training of engineering students, which would help them to reach sustainable solutions.
In this test, the Experiment Group participants increased their legibility level by 3.34 points, meaning they felt less conditioned to follow predetermined paths. In relation to flexibility, the improvement obtained a high value for the benefit of the Controlled Group (4.19). They also increased their ability to generate more ideas into original shapes, which is the main core of creativity.
The semi-open question test allows students to respond and focus on the subject matter in order to arrive at possible

consequences. Figure (2.6) shows two levels of questions where the same student used a wheel as an example to express a circle and split the shapes in an organized manner, using the same acrylic primary colors that the students had used in projects, even though they were using software containing endless choices.

The other two figures show the second level, where more precise questions were used, expressing a moving object, and dividing the shapes into groups of harmonious dynamic pieces, using a split-complementary color scheme resulting in cohesiveness by emphasizing the similarities of separate but related parts.

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The other two figures show the second level, where more precise questions were used, expressing a moving object, and dividing the shapes into groups of harmonious dynamic pieces, using a split-complementary color scheme resulting in cohesiveness by emphasizing the similarities of separate but related parts.

The study participants found gains in design when starting with pieces of information that emphasized the necessity of finding a single solution to a given problem. This was the outcome of their conducting the identical exam at two separate colleges and then repeating the test at each of those universities. Because uncertainty compels students to think in the most effective manner they are capable of, and because this in turn leads to various students making different decisions and going in different directions, this mode of thinking needs to be incorporated into regular classroom instruction.

It's possible that the unpredictability of the information employed in the design is what makes the most significant difference in the results of the research when comparing level one, which makes use of divergent questions, to level two, which makes use of convergent questions. This information may give some indication on the scope of the students' collective understanding.

The questions served a variety of purposes: some were meant to elicit reasons and explanations from the respondents, while others were designed to glean information from them.

The Learning System should make greater use of open space in the learning process, but this should be done so in a way that is gradual and instructive. This will help to raise students' levels of assurance and encourage them to freely express themselves.

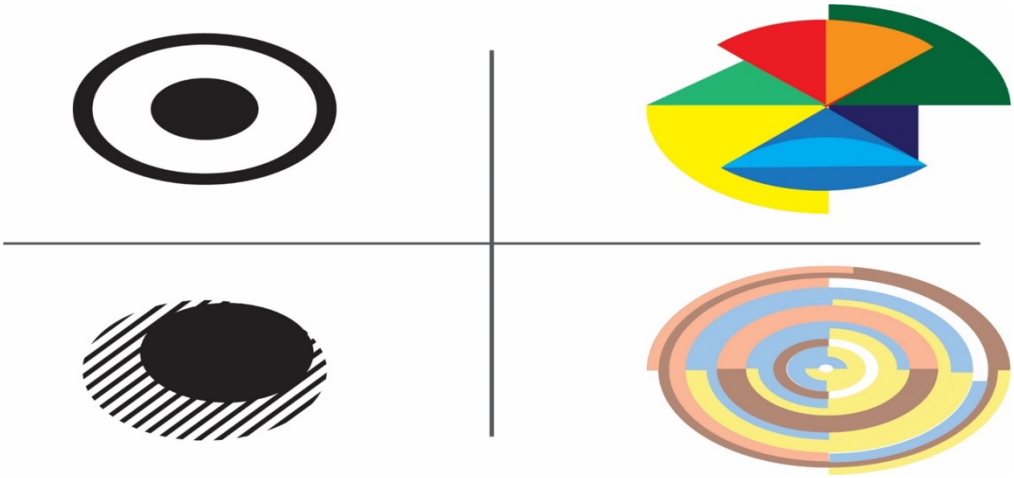

Fig.2: The first raw shows a sample of the Experiment Group results and the second raw shows a sample for the Control Group

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