“Comparative Analysis of Written and Verbal Ideation Techniques in Enhancing Creative Output among Iranian Students of Industrial Design”

Abstract:

In educational paradigms, particularly within the domains of art and industrial design, creative thought is heralded as a cornerstone for academic and professional success. Students in these disciplines are lauded for their ability to conceptualize new products and services through innovative ideation. A gamut of pedagogical strategies and methodologies has been adopted to enhance and expedite the ideation process for aspirant industrial designers and architects. This scholarly treatise examines the discrete impacts that verbal and written creative techniques exert on the ideation efficacy of students engaged in architecture and industrial design disciplines. The manuscript commences by establishing the criticality of the ideation phase within the industrial design and architectural creation process, followed by an exposition on the integration of creativity-fostering instruments therein. Subsequently, the study expounds upon two preeminent tools—namely, ‘Brainstorming,’ a technique predicated on verbal creativity, and ‘Brainwriting,’ a written creativity-facilitating technique. These methods are identified as benchmark practices in workshops geared toward the forestation of ideas and product design. Empirical evidence from this study was garnered through the observation of 48 students categorized into 8 distinct cohorts. These groups undertook the task of idea generation for two design challenges: crafting a game for visually impaired children and for individuals with paraplegia, utilizing the stipulated tools. The findings revealed that the Brainwriting technique yielded a higher quantity and variety of ideas compared to that of Brainstorming. Nonetheless, the data suggests a parity in the caliber of ideas generated between the two methodologies. There was, however, a discernible predilection for the unique types of ideas that emanated from the Brainwriting approach. In contrast, the Brainstorming technique was noted for fostering an environment rich in engagement and conviviality. The cultural and linguistic underpinnings that might influence these observed dichotomies remain areas ripe for exploration in subsequent research endeavors.

Key words: Brainstorming, Brainwriting, Creativity Techniques, Industrial Design Process, Idea-generation.

1-Introduction

Creativity and innovation are recognized as critical factors influencing the acceptance or rejection of design solutions. The founding of creative design studios on a global scale, the proliferation of literature advocating the amalgamation of creative approaches with systematic design processes,

diffusion of scholarly articles in esteemed academic journals, and the organization of specialized workshops all aim to fortify the foundational aspects of ideation and product innovation. In addition to the dissemination of scholarly works on innovation in a broad context, there has been an uptick in the publication of texts that juxtapose innovation and creativity with the process of product design.

An understanding of the multifaceted nature of creativity, analyzing the creative process and idea generation in humans, as well as the identification of factors that either augment or constrain creativity, alongside methodologies for fostering ideation and creativity, constitute some of the most engaging topics. These topics are frequently consulted and studied, particularly among novice industrial designers and academicians in the field (Lawson, 2006).

Reviewing the literature reveals that traditional product design followed a linear process, mapped out across several phases, commencing with the definition of the project scope and culminating with the fabrication and user testing of a tangible prototype (Amraee, 2013; Hawkes & Abinett, 1986; Jones, 1970; Van der Linden et al., 2011). In general, this process is often delineated and summarized within a tripartite, "diamond-shaped" framework, articulated through two prevailing theoretical models (as depicted in fig. 1).

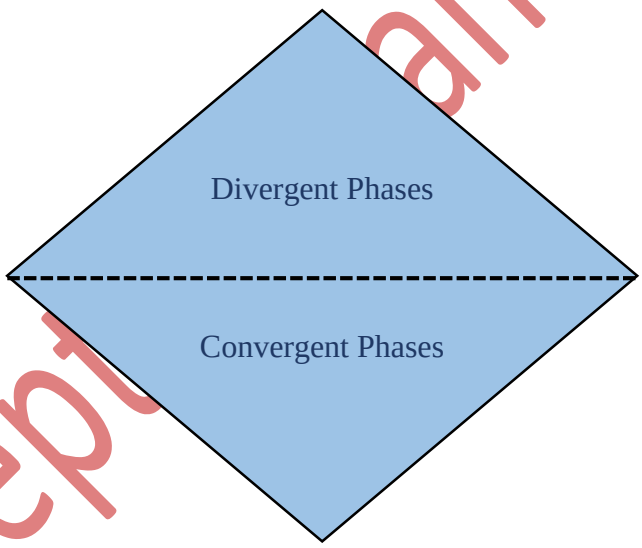

Figure 1: Sequential Phases Undertaken by a Prototype within Systematic Product Design Methodology (Tassoul, Marc & Buijs, 2006).

Within the established systematic design framework, considerable emphasis is placed on the stages of idea generation and the inception of novel designs as pivotal, divergent phases essential to the realization of designs that resonate with end-users (Buijs et al., 2009; Cross et al., 2002). Consequently, the exploration of methodologies that amplify creativity and facilitate the generation of ideas acquires significant prominence within the industrial design process; the acquisition of efficacious and practical design tools to attain innovative and creative outcomes is integral to this endeavor.

In pursuit of this goal, scholars and theorists within the domain of product design have leveraged the insights of cognitive science and specifically, the field of creativity and innovation research (Dorst & Cross, 2001). Alex Osborn's (1957) advent of the "Brainstorming" method has established a foundational collaborative approach in the elicitation of creative ideas. Over half a century since its introduction, numerous empirical studies have been conducted, attesting to its widespread applicability and effectiveness in generating novel and initial ideas (Franco et al., 2017; Tassoul, 2012). Brainstorming's capacity for engendering a multitude of diverse ideas has led to its prevalent use in short-term creative workshops as well as in broader studies focused on innovation and creativity (Van Boeijen et al., 2020).

However, investigations aimed at rectifying the apparent and documented limitations of this method have given rise to the "Brainwriting" technique, posited as an alternative to the traditional verbal brainstorming (Geschka, 1980; Geschka et al., 1973). Furthermore, extensive empirical research by Arthur B. VanGundy (1986) suggested the superiority of the written method, culminating in the proposition that brainwriting is generally more productive and effective than its verbal counterpart (Vangundy, 1984). These findings have been corroborated due to certain shortcomings in the brainstorming approach, such as the potential for individual domination during idea-generation sessions, highlighting the increased generative capacity of the brainwriting technique (Heslin, 2009).

The practical examination of methods that enhance creativity within specific regional conditions and their alignment with the educational requisites of Iran is deemed an essential undertaking, necessitating extensive research. This empirical study assesses and juxtaposes the differing impacts of two recognized and prevalently employed ideation methods within creative group settings and workshops. On one hand, the brainstorming technique is scrutinized as a quintessential verbal method, commonly applied in Iran's product design workshop settings. On the other hand, brainwriting, as a written-based counterpart to brainstorming, is evaluated. The efficacy of both techniques in facilitating idea generation is empirically compared within the context of their application in 'Industrial Design Project 4' (focused on creativity and rapid design) (Fig. 2).

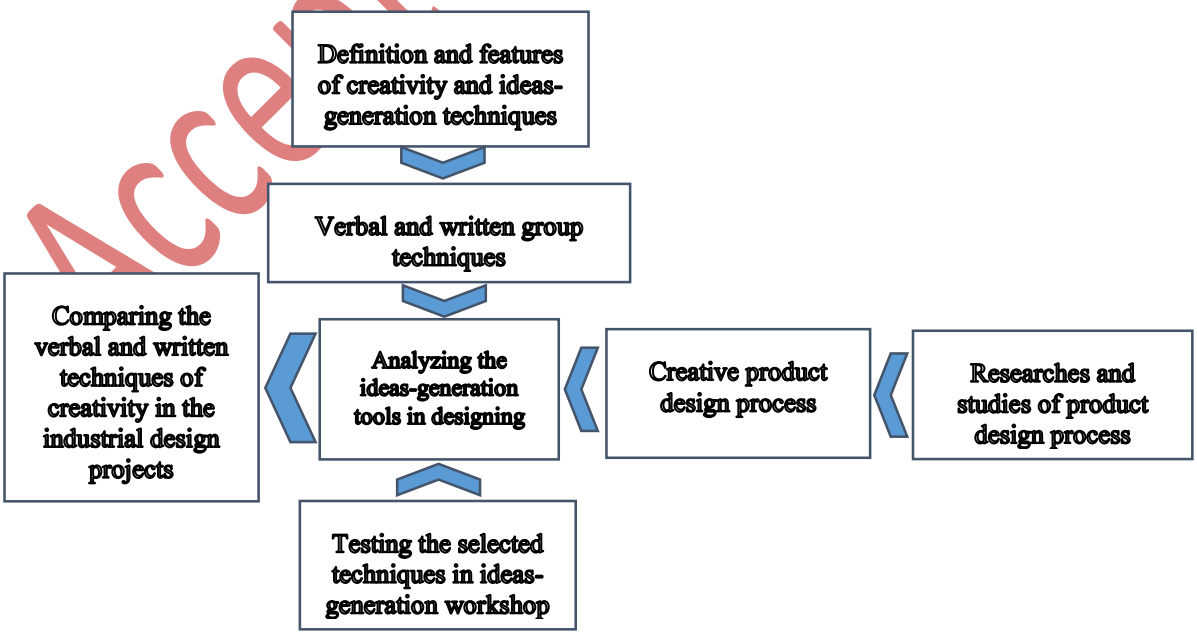

Figure 2: General framework of current study.

2 - The Process of Product Design

The discipline of product design, or industrial design, within the Iranian context is recognized as an orderly and systematic procedural trajectory with delineated inception and conclusion points, a perception that is acknowledged in a global and comprehensive manner. Tracing back to when Booz et al. (1967) articulated a conceptual framework for engineering design and its respective phases, through to the era where the international design consortium (2006) reinforced this paradigm, one can envisage a sequential procedure encapsulated within six distinct stages as depicted in Figure 3. Drawn from these scholarly contributions, the product design process initiates with the discernment of user necessities and proceeds to scrutinize both functional and aesthetic requisites. This is followed by the generation of a multitude of design concepts. Upon the refinement and selection of superior solutions, the design is then elaborated in detail. The culmination of this linear design journey is marked by the fabrication of a prototype which is then subjected to empirical assessment by target user groups (Howard et al., 2008).

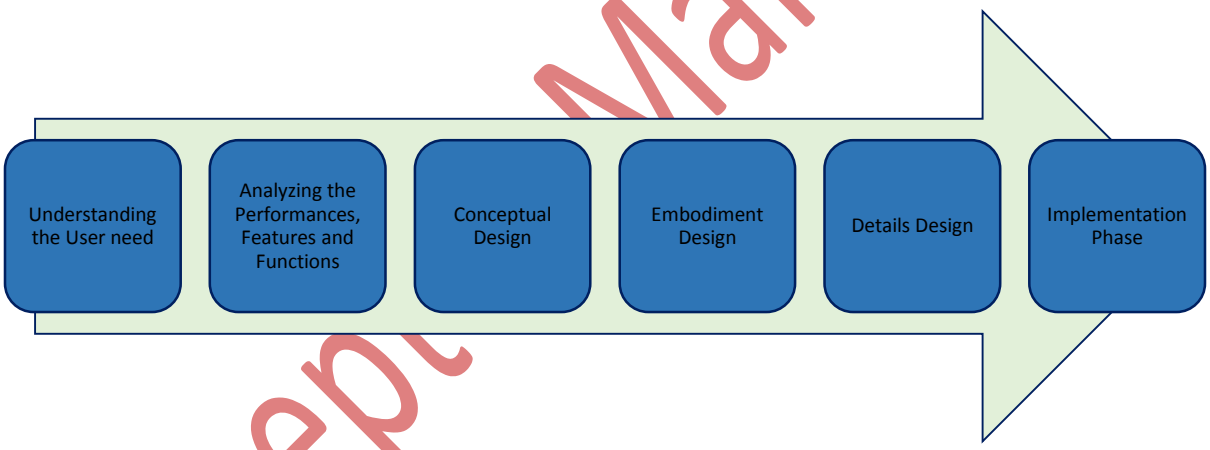

Figure 3: Diagram illustrating the linear process of systematic product design (Howard et al., 2008).

Regarding the comparison between the different expressed in the image above, two initial stages of the process be combined between them as the identification of the subject and precise definition of the problem and on the other hand, the design stages of the embodiment the details can combined because the evaluation and selection steps can be obtained to obtain a four-step model. Therefore, the table summarized below can be presented a complete and brief substitute to the design process:

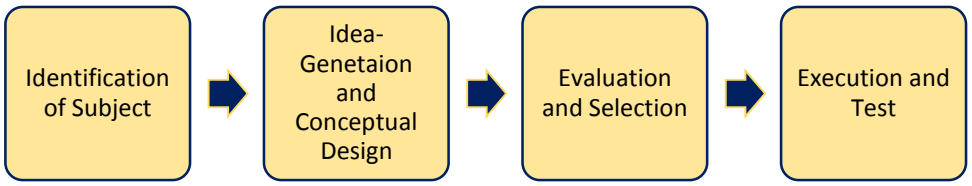

*Figure 4: Comprehensive and brief process of industrial design (*Drawing: by authors).

With regard to the second stage of the process the particular place and determinant of the proposition of the can be considered as a divergent stage. Without considering it, the design process of response products will be effective and pure and therefore, one also study better and innovative product design, from the research of creative design researchers.

2.1. Creative and innovative product design process

Among the different definitions proposed during the last two methods presented during the last decade be observed with a particular emphasis on the element creativity innovation in product design. The first method is related to the design process by researchers in the field of product innovation management of the Faculty of Industrial Design Engineering of the University of Technology Delft, one of the main ones in this field. In Delft innovation method, the main focus is on using the product and survey the market and user requirements in order to formulate a new production strategy and create innovation in the product (Buijs, 2012).

In addition, Kuo-hsiang Chen presented a creative process product design as a method coherent and systematic. In this context, it is suggested to use creativity techniques from CPS studies. In the recent process, in the category of Generating and Developing Product Concepts, brainstorming and brainwriting have been recommended to designers (Chen, 2008). Each of these two processes presents aspects of and similarity of which the phases were written on:

*Table 1: Comparison of phasing two methods of creative product design (*Drawing: by authors).

Phase	Delft Innovation Method	Creative Product Design
First	Creating a Design Goal	Identifying Users/Consumers Needs
Second	Creating Product Ideas and Concepts	Generating and Developing Product Concepts

Third	Decision and Selection	Selecting/Evaluating Product Concepts
Fourth	Evaluation of Product Features	Prototyping and Testing

As shown in Table 1, in both design, in the second phase, conceptual design and proposal ideas were mentioned. In this phase, the designer, without any boundaries or presents many and varied ideas and provides them to access the many alternative possibilities appropriate for the problem expression. These processes, in order to achieve this desirable goal, suggested different tools and techniques of creativity and put on their use. The most famous creativity tools suggested by the two methods include brainstorming, brainwriting, mindmapping, scamper, synectics, morphological diagram, functional analysis, storyboard and collaborative design techniques.

2.2. Creativity and innovation in design

According to Leonard-Barton and Swap (1999), the etymology of the term "innovation" can be traced back to the Latin word "Novus," meaning "new," suggesting the notion of "creating something new." In the English language dictionary, innovation is defined as the act of introducing a new entity (Leonard-Barton & Swap, 1999). More recent definitions characterize innovation as a creative operational objective involving the integration and coordination of scientific principles in the development of novel, significant, and valuable products, processes, and services, (Tidd et al., 2020). Additionally, some definitions emphasize innovation as a process extending beyond the mere promotion of good ideas, focusing on the practical development of ideas for practical application, as highlighted by Meier and Baldwin (Meier & Baldwin, 1957).

Furthermore, product innovation is recognized as a pivotal factor in commercial innovation, with creative design playing a central role in the innovation of products to ensure sustained success in a highly competitive international marketplace (Li et al., 2007). Consequently, the significance of creativity is paramount for successful design and production. According to Stenberg (1995), intelligence, knowledge, cognitive style, personality, motivation, and environmental factors directly influence an individual's creativity. Therefore, the implementation of various practices and educational tools for fostering creativity can empower designers and students to generate novel ideas and innovative solutions. These methods and tools have been endorsed by several sources, following empirical studies (Jones, 1970; Lawson, 2006). The utilization of established and validated facilities and techniques for creativity and idea generation has consistently been advocated by experts, with the attainment of favorable outcomes being foreseeable as a consequence of their application.

3. Techniques of Creativity and Idea-Generation Phase

Creativity techniques serve as instrumental tools for generating solutions to address well-defined problems. The majority of these methods are of a general nature and are utilized to solve a wide

range of scientific and interdisciplinary issues. These techniques represent advancements within the field of psychology known as Creative Problem Solving (CPS), which is recognized as a dynamic approach to the process of learning and teaching (Puccio & Cabra, 2008; Tang et al., 2012). These tools are very useful and effective to produce several number of ideas in short time meeting (Van Boeijen et al., 2020).

The primary characteristics of creativity techniques include the following (Kelley & Littman, 2005):

1. Heightened engagement in the learning process
2. Enhanced motivation throughout the learning procedure
3. Elevated expectations among learners in terms of problem-solving
4. Greater autonomy and diminished feelings of resignation
5. Skill acquisition across diverse domains
6. Improved morale within group work settings
7. Fostering of creativity and innovation among learners.

Generating a substantial volume of ideas and innovative solutions to a given problem has been identified as a key indicator of creativity among learners, an attribute initially characterized as "fluency" by Ellis Paul Torrance (1960s). Moreover, the substantial diversity of the ideas put forward represents a second crucial aspect of creativity, now referred to as "flexibility" (Torrance & Shaughnessy, 1998).

Additionally, an appropriate atmosphere during ideation sessions can promote the expression of creative possibilities among group members. The favorable conditions of the educational environment, including its appeal and the quality of its facilities, can effectively enhance the ideation capacity (Mirkamali & Khorshidi, 2009; Van Boeijen et al., 2020).

In the context of idea generation sessions, it is essential to consider three key factors: the quantity and number of ideas generated, the quality of those ideas, and the overall atmosphere that governs the idea-proposing session.

Firstly, the quantity and number of ideas produced play a significant role in the ideation process. By encouraging a high level of participation and fostering an environment that promotes idea sharing, a larger pool of ideas can be generated. This allows for greater diversity and increases the likelihood of finding innovative and unique solutions.

Secondly, the quality of the ideas generated is crucial. It is important to foster an atmosphere that encourages participants to think critically, explore various perspectives, and challenge conventional thinking. By promoting a culture of open-mindedness and constructive feedback, the quality of ideas can be improved, leading to more viable and effective solutions.

Lastly, the atmosphere governing the idea-proposing session is a fundamental factor in determining its success. Creating a supportive and inclusive environment where participants feel comfortable expressing their thoughts and ideas is essential. By encouraging active participation,

respecting diverse viewpoints, and fostering collaboration, the overall atmosphere can enhance creativity and promote a sense of ownership and commitment to the ideas generated.

In conclusion, when considering idea generation sessions, it is crucial to focus on the quantity and number of ideas, the quality of those ideas, and the atmosphere that governs the session. By prioritizing these factors, organizations can foster a culture of innovation and creativity, leading to the development of valuable and groundbreaking solutions. As a result, attaining an optimal condition for the generation of ideas and fostering an environment conducive to the presentation and emergence of creativity are crucial considerations in the selection and implementation of techniques associated with the subset of creative problem-solving. Therefore, the structure presented in the (fig. 5) can be considered as the determining factors of success or failure of a creativity technique.

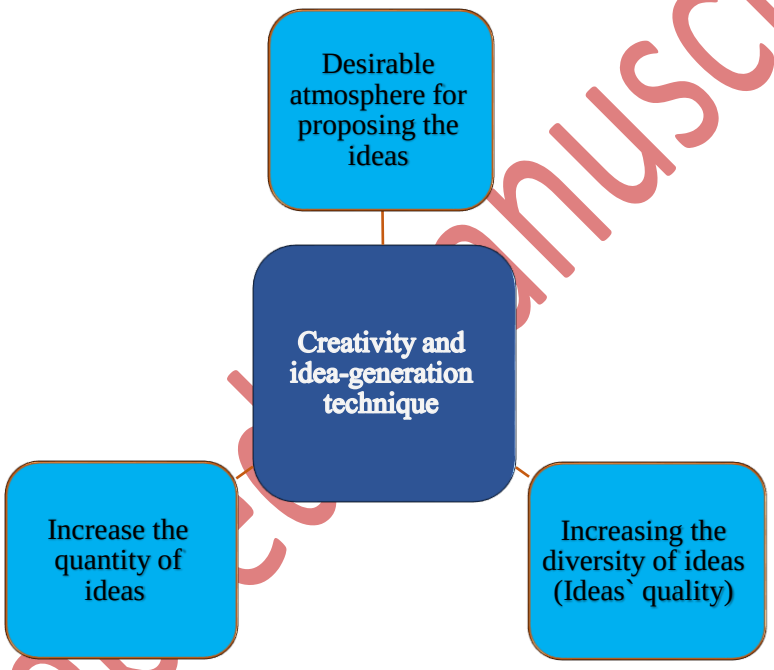

*Figure 5: Three pivotal and influential factors in the success or failure of techniques and methods for fostering creativity and idea generation (*Drawing: by authors.)

For the evaluation and comparison of homogenized creativity techniques for idea generation, three determining factors can be considered.

In the context of Iran, the classification of creativity techniques has predominantly revolved around the extent of inclusivity and accessibility they offer, thereby yielding three primary categories (Mirkamali & Khorshidi, 2009):

1. Individual creativity techniques

2. Group creativity techniques

3. Individual-group creativity techniques.

This taxonomy primarily hinges on the number of participants involved in the process of idea generation within these techniques. Within this conventional categorization, particular emphasis is placed on the utilization of group-based methodologies for idea generation, with the intention of fostering a diverse range of ideas originating from the participants, and thus, their distinct perspectives. This emphasis is particularly prominent during the initial stage of idea proposal, wherein the primary objective is to generate a multitude of numerous and diverse ideas (Tassoul, 2012). Notably, brainstorming and brainwriting are among the most recognized and widely used methods for group idea generation.

3.1. Brainstorming: the verbal model of group creativity technique

As one of the most commonly employed and practical approaches to foster creativity across various disciplines, workshops and educational classes serve as the familiar and accessible methods and tools for facilitating idea generation. Brainstorming is extensively employed as a prominent strategy to foster the creative thinking abilities, while also affording individuals valuable guidance and opportunities for the presentation of novel and inventive ideas (Draze, 2005; Hatchuel et al., 2009; Tang et al., 2012). Brainstorming "is a tool to generate, in a group, creative conclusions for a specific problem by gathering a list of ideas coming out spontaneously during a group session by its participants" (Franco et al., 2017). The method of group idea-generation, known as brainstorming, was originally introduced by Alex Faickney Osborne in his seminal work "Applied Imagination" (1957). This approach has since gained significant traction as a powerful tool for facilitating collective idea generation within groups. By harnessing the potential of brainstorming, diverse and divergent ideas can be generated in abundance, thereby enhancing the creative output of the group (Heslin, 2009). The optimal size for a group engaged in ideation has been recommended to range between 4 to 8 individuals. This configuration facilitates idea-generation through group communication and discourse, enabling participants to freely express their thoughts and perspectives. During this process, the generated ideas are documented on paper without any form of censorship or criticism, promoting a non-judgmental environment conducive to the free flow of creative concepts (Van Boeijen et al., 2020). The effective implementation of brainstorming entails the consideration of several key factors; these factors include (Kelley & Littman, 2005):

1. Time allocation: Establishing a designated timeframe for the brainstorming session ensures that participants can focus their efforts within a defined period, promoting efficiency and productivity.

2. Generating a large quantity of ideas: Encouraging the generation of a high number of ideas fosters a rich pool of creative concepts, increasing the likelihood of innovative solutions.

3. Suspending judgment and criticism: Creating an environment devoid of judgment and criticism allows participants to freely express their ideas without fear of negative evaluation, thus facilitating uninhibited ideation.

4. Encouraging free thinking: Stimulating the exploration of unconventional and unrestricted ideas promotes the emergence of innovative and groundbreaking concepts.

5. Valuing the contributions of others: Emphasizing the importance of considering and building upon the ideas contributed by fellow group members cultivates an atmosphere of collaboration and mutual respect.

6. Maintaining focus on the subject: Sustaining concentration on the central topic or problem at hand ensures that the generated ideas remain relevant and aligned with the intended objectives.

7. Incorporating visual thinking: Harnessing the power of visual imagery aids in the ideation process by fostering creative associations and stimulating alternative perspectives.

Overall, participants in brainstorming sessions tend to thrive in the collaborative and supportive atmosphere, leading to increased idea generation and a greater potential for creative outcomes (Heslin, 2009).

3.2. Brainwriting: the written model of group creativity technique

This tool has gained recognition and endorsement as a facilitated event and viable alternative to traditional brainstorming (Vangundy, 1984). Brainwriting has transformed the idea generation process from oral communication among group members to a written phenomenon, enabling all participants to equally contribute novel ideas. This technique establishes an environment conducive to written expression, facilitating the free flow of creative concepts and ensuring equitable participation (Childs et al., 2022). In recent decades, various forms of brainwriting have been developed and implemented as problem-solving approaches. One prominent method among these is the 3-5-6 technique, widely recognized for its effectiveness in executive settings. In this technique, each group member individually writes down their ideas on dedicated sheets of paper. By adopting this approach, the drawbacks of group monologues and the potential isolation of certain members are mitigated, ensuring maximum participation and collaboration among all group members (Van Boeijen et al., 2020). In addition to the aforementioned 3-5-6 tactic, various other methods have been employed in the practice of brainwriting. Among these methods, the nominal brainwriting technique has garnered recognition and is frequently utilized, particularly in the context of organizational and curricular ideation. This classic approach involves the use of nominal brainwriting as a means to stimulate idea generation within these domains.

4. Execution and Discussion

Tassoul (2012) has classified both brainstorming and nominal brainwriting as associative techniques within the realm of ideation. These techniques are recognized for their capacity to facilitate the generation of a substantial quantity of innovative solutions and high-quality ideas within the ideation group (Tassoul, 2012). Therefore, they have been able to use in the prime of ideation phase to present a several range of design ideas and concepts (Van Boeijen et al., 2020).

As a result, the conditions necessary for generating a plethora of diverse ideas in a stimulating environment are successfully established. Consequently, the atmosphere of the ideation session is encouraging and motivating, leading to increased participation from the group members.

In the practical workshop of Design Project 4, commonly known as the "Creativity and Quick Design" project, the verbal technique of brainstorming and the written technique of brainwriting were selected as the creativity tools for group ideation. These techniques were utilized and tested from October 2019 to November 2023 across four distinct stages. The participants in this study were undergraduate students enrolled in the Industrial Design course, specifically in the fifth and seventh terms.

Throughout the stages, a total of 48 students were organized into separate groups of six individuals, adhering to the standard and conventional group size specified in the 3-6-5 tactic of brainwriting. The members within each group remained consistent, forming the idea-generation group for the brainstorming session with a new subject.

The initial phase involved the formation of octal idea-generating groups, led by appointed group leaders. Each group was allocated a 30-minute session dedicated to proposing solutions related to the subject of "designing a game device for blind children." During this session, strict guidelines were in place, prohibiting the use of cellphones and leaving the ideation session. This ensured that participants remained fully engaged and focused on the task at hand. At the end of the session, a comprehensive compilation of ideas generated by the group members was documented.

Figure 6: The group of students in industrial design course that are proposing their ideas in using of brainstorming.

Following a brief intermission, the idea-generation groups reconvened with the same composition and under equitable circumstances, this time focusing on presenting suitable ideas for the topic of

"designing a game device for paraplegic children" using the written technique of brainwriting. Similar to the previous session, a timeframe of 30 minutes was allocated for this stage. To facilitate the recording of ideas, a specific form (Fig. 7) was provided to each group member.

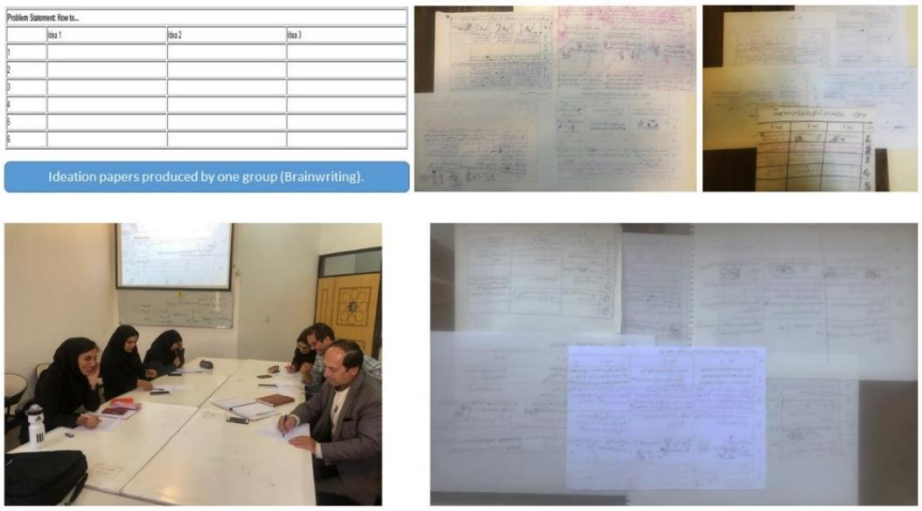

Figure 7: The sample of the form of mental writing ideas-proposing for recording the ideas of ideas-proposer groups.

Upon the conclusion of the ideation phase by the groups, workshop participants were instructed to independently evaluate two specific ideation tools. These assessments were to be conducted across three distinct dimensions:

1. Quantity and number of produced ideas,
2. Quality of produced ideas,
3. Atmosphere governing the idea-proposing session

Finally, the participants were asked to disclose their overall assessment and indicate their preferred technique by selecting a number from 0 to 7. This ranged from 1 (strongly disagree) to 7 (strongly agree) for each of the study parameters at the conclusion of the idea-generation meeting.

The outcomes obtained from the implementation of techniques by students in the field of industrial design are presented in a visual format, specifically in the form of charts and tables. These graphical representations provide a comprehensive and organized display of the results achieved, allowing for a clear and concise understanding of the data.

Table 2: The mean of weight and score results of participators separately according to the triple factors (from the number 7).

No.	creativity technique	Quantity and number of ideas	Quality of ideas	Proper atmosphere

1	Brainstorming	4.2812	4.8125	6.01
2	Brainwriting	6.1875	5.6875	4.1562

Based on the obtained scores, brainwriting has demonstrated superiority in terms of the ability to generate a large number of ideas as well as the quality of ideas. Conversely, brainstorming has exhibited a higher level of facilitation in creating an atmosphere conducive to idea generation and fostering creativity among students. These findings highlight the distinct strengths and characteristics of each technique in promoting idea generation and creativity within the context of this study.

Figure 8 presents the chart depicting the participants' personal preferences following their engagement with two selected creativity tools during the idea generation process. A preliminary observation reveals that participants favored brainwriting due to its ability to generate a greater quantity of ideas, whereas they preferred brainstorming for its conducive and encouraging atmosphere. However, it is noteworthy that the quality of ideas generated through both brainstorming and brainwriting remained consistent. These findings indicate that while the two techniques differ in terms of quantity and atmosphere, they exhibit comparable outcomes in terms of idea quality.

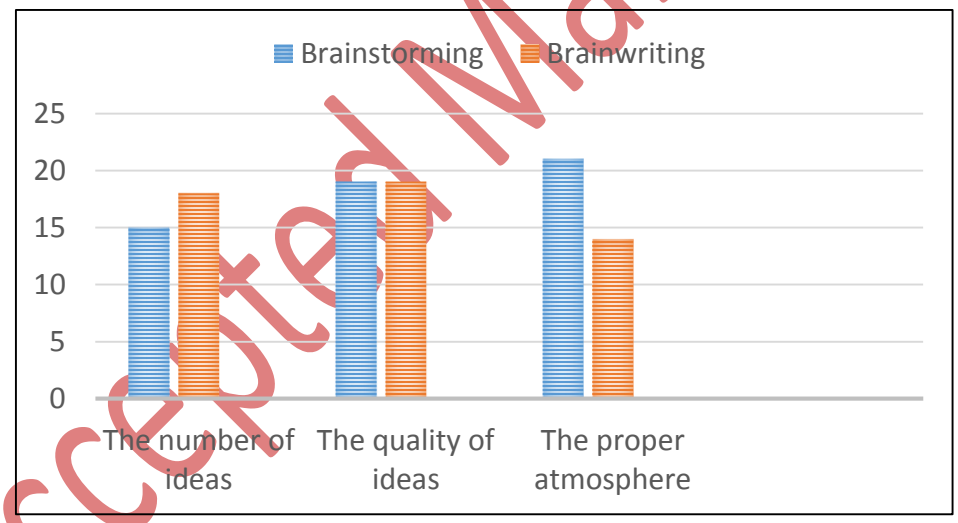

Figure 8: The number of selection and amount of fortune luck of each one of the techniques separately in three determined factors.

Despite the participants' inclination towards brainwriting as their preferred method for generating a large number of ideas, it is important to note the notable distinction in terms of the conducive and energizing atmosphere of the brainstorming technique when compared to other samples. This difference in the ideation group's experience with brainstorming warrants further evaluation and analysis, highlighting the unique attributes and potential benefits associated with the atmosphere created during brainstorming sessions.

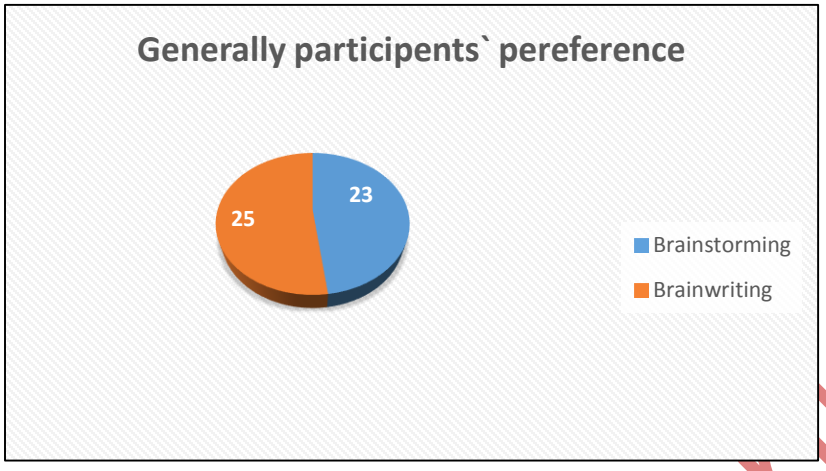

Figure 9: The difference of preference of young idea-generation groups in selecting and using of two creativity techniques.

Figure 9 presents a comprehensive depiction of the participants' overall acceptance and preference regarding the two techniques examined:

The analysis of the charts reveals that the participants displayed a general inclination towards brainwriting, primarily due to its efficacy in generating a larger volume of diverse solutions. Simultaneously, they expressed appreciation for the conducive and encouraging atmosphere facilitated by brainstorming. This indicates that while the participants were more satisfied with the atmosphere of the brainstorming session, their preference for generating a greater quantity of ideas was inclined towards the brainwriting technique. Consequently, the possibility of designing hybrid idea generation methods that incorporate both techniques explored in this study emerges as a promising avenue for further research and exploration.

5. Conclusion

The integration of various scientific disciplines, such as psychology, has long been embraced by industrial design researchers. In the domain of product design, the utilization of Creative Problem Solving (CPS) and its associated methods holds significant importance in the phase of "Idea Generation and Conceptual Design." Among the methods applied to facilitate creativity, group techniques like brainstorming and brainwriting have gained prominence.

The present study focuses on investigating these two group techniques with respect to the quantity of ideas generated, the quality of ideas produced, and the conducive atmosphere in which they are generated.

1. The brainwriting technique surpasses brainstorming in terms of the quantity and diversity of ideas generated. The characteristic silence that pervades the group during idea generation, coupled with the imposition of time constraints for each round, promotes focused and accurate ideation, ultimately resulting in a greater number of proposed ideas.

2. Although the number of selected ideas remains comparable, participants exhibit a stronger inclination towards the brainwriting method in terms of generating high-quality, original solutions. This preference suggests a deeper appreciation for the brainwriting technique among idea selectors compared to brainstorming.

3. In terms of establishing verbal and unrestricted communication among group members, brainstorming fosters a more positive, exhilarating, and suitable environment for idea generation than its written counterpart. Consequently, students engaged in idea generation derive greater enjoyment from the brainstorming process, experiencing an enhanced atmosphere.

Exploring the underlying reasons behind these findings could contribute to the field of design and independent research. Understanding why industrial design students favor speech-based techniques like brainstorming over writing-based techniques may be rooted in cultural and social conditions, or could be attributed to other significant factors. This topic presents an intriguing avenue for future research endeavors.

6. **References:**

Amraee, B. (2013). *Postmodern and Meta-Industrial Design* (1st ed.). Tabriz Islamic Art University.

Buijs, J. (2012). The Delft Innovation Method A Design Thinker ' s Guide to Innovation. In Assoc. Prof. K. A. J. Assoc. Prof. Poul Kyvsgaard Hansen, Professor John Rasmussen (Ed.), *NordDESIGN2012*. 1: Aalborg University, Denmark; 2: Design Society, United Kingdom.

Buijs, J., Smulders, F., & van der Meer, H. (2009). Towards a More Realistic Creative Problem Solving Approach. *Creativity and Innovation Management*, *1*(2), 286–298. https://doi.org/10.1111/j.1467-8691.2009.00541.x

Chen, K. (2008). *Creative Product Design*. CULTURAL AND CREATIVE PRODUCTS, Taiwan Institute of Kansei.

Childs, P., Han, J., Chen, L., Jiang, P., Wang, P., Park, D., Yin, Y., Dieckmann, E., & Vilanova, I. (2022). The creativity diamond—A framework to aid creativity. *Journal of Intelligence*, *10*(4), 73.

Cross, N., Keynes, M., & Uk, M. K. (2002). Creative Cognition in Design: Processes of Exceptional Designers. *Creativity and Cognition*.

Dorst, K., & Cross, N. (2001). Creativity in the design process: Co-evolution of problem–solution. *Design Studies*, *22*(5), 425–437. https://doi.org/10.1016/S0142-694X(01)00009-6

Draze, D. (2005). *Creative Problem Solving for Kids*. Prufrock Press. https://books.google.com/books?id=dtFmwRtVH8EC

Franco, P., Kearns, Liviana, Valtonen, David, Jaspers, J., & Kommers, P. (2017). *CREATIVE PROBLEM SOLVING METHODOLOGY GUIDE*. https://doi.org/10.13140/RG.2.2.35949.64484

Geschka, H. (1980). *Methods and organization of idea generation* (1st ed.). S. Gryskiewicz.

Geschka, H., Schaude, G. R., & Schlicksupp, H. (1973). Modern techniques for problem solving. *Chem Eng*, *80*, 91–97.

Hatchuel, A., Masson, P. L., & Weil, B. (2009). Design Theory and Collective Creativity: Theoretical Framework to Evaluate KCP Process. *International Conference on Engineering Design*, *6*, 277–288.

Hawkes, B., & Abinett, R. (1986). *The Engineering Design Process*. Longman Scientific & Technical.

Heslin, P. A. (2009). *Better than brainstorming? Potential contextual boundary conditions to brainwriting for idea generation in organizations*. 129–145. https://doi.org/10.1348/096317908X285642

Howard, T. J., Culley, S. J., & Dekoninck, E. (2008). Describing the creative design process by the integration of engineering design and cognitive psychology literature. *Design Studies*, *29*(2), 160–180. https://doi.org/10.1016/j.destud.2008.01.001

Jones, J. C. (1970). *Design methods: Seeds of human futures*. Wiley-Interscience.

Kelley, T., & Littman, J. (2005). *The ten faces of innovation: IDEO's strategies for beating the devil's advocate and driving creativity throughout your organization*. Currency.

Lawson, B. (2006). *How Designers Think – The Design Process Demystified*. Architectural Press.

Leonard-Barton, D., & Swap, W. C. (1999). *When sparks fly: Igniting creativity in groups*. Harvard Business Press.

Li, Y., Wang, J., Li, X., & Zhao, W. (2007). Design creativity in product innovation. *The International Journal of Advanced Manufacturing Technology*, *33*, 213–222.

Meier, G. M., & Baldwin, R. E. (1957). Economic development: Theory, history, policy. *(No Title)*.

Mirkamali, S.-M., & Khorshidi, A. (2009). *Methods of Nrturing Creativity in Educational Systems* (1st ed.). Yastoroon.

Puccio, G., & Cabra, J. (2008). Creative problem solving: Past, present and future. In *The Routledge companion to creativity* (pp. 327–337). Routledge.

Tang, H.-H., Chen, Y.-L., & Gero, J. S. (2012). *The influence of design methods on the design process: Effect of use of scenario, brainstorming, and synectics on designing*.

Tassoul, M. (2012). *Creative facilitation*. Vssd.

Tassoul, Marc & Buijs, J. (2006). *Clustering, from diverging to converging in CPS process*. Delft TU.

Tidd, J., Bessant, J. R., & Pavitt, K. (2020). *Managing innovation: Integrating technological, market and organizational change* (3rd ed.). John Wiley & Sons.

Torrance, E. P., & Shaughnessy, M. F. (1998). An Interview with E. Paul Torrance: About Creativity. *Educational Psychology Review*, *10*(4), 441–452. JSTOR.

Van Boeijen, A., Daalhuizen, J., & Zijlstra, J. (2020). *Delft design guide: Perspectives, models, approaches, methods* (2nd ed.). BIS Publishers. https://www.bispublishers.com/delft-design-guide-revised.html

Van der Linden, J., Lacerda, A., & Aguiar, J. (2011). *The evolution of design methods*.

Vangundy, A. B. (1984). BRAIN WRITING FOR NEW PRODUCT IDEAS : AN ALTERNATIVE TO BRAINSTORMING. *Journal of Consumer Marketing*, *1*(2), 67–74.