HOW CAN AI SUPPORT THE CREATION OF NOVEL IDEAS IN PRODUCT DESIGN

Victoria HAMILTON[1,2], Ross BRISCO[1] and Hilary GRIERSON[1]
[1]Department of Design, Manufacturing and Engineering Management, University of Strathclyde, United Kingdom
[2]Hunter Centre for Entrepreneurship, University of Strathclyde, United Kingdom

ABSTRACT

The rise of Artificial Intelligence (AI) provides an exciting opportunity in many fields and aspects of life. In the field of design, one area to be explored, is how AI could be used to support a designer to develop more novel ideas at the idea generation stage of the product development journey. In this paper, we explore how AI can be utilised to support a traditional 6-3-5 creative design methods workshop, and whether it increases the novelty of the concepts. In our workshop, students were tasked with using the 6-3-5 method to generate ideas for a product which could make life easier for an arthritis sufferer when undertaking tasks in the kitchen. Some of the students were advised they could use ChatGPT to support idea creation; some of the students were advised they could use Google to support idea creation; and the remaining students were advised they would not be able to use any additional support for idea generation. This group was considered as the control group. A feedback survey was distributed among the participants to gather their thoughts on whether the use of AI/Google had assisted them in the application of the design method to generate more novel and creative concepts. Further analysis was then conducted, with a focus on novelty, on the outputs of the 6-3-5 to assess whether the novelty of the concepts in the AI/Google groups was greater than that of the control group. The results of the workshop indicated that the ideas generated with AI support were more novel than those without, and that students utilising AI became more relaxed in their approach to idea generation, relying on AI before fully exhausting their own ideas. Interestingly, the perceived helpfulness of AI was also not fully appreciated by the more novice designers in comparison to those more experienced designers. In this paper we discuss how AI could be used by educators to support teaching and application of more creative design methods such as 6-3-5.

Keywords: P-I-T method, 6-3-5 method, 6-3-5 brainwriting, creative design methods

1   INTRODUCTION & LITERATURE REVIEW

Design methods are used to guide and support the design process. They are used by design practitioners to justify decisions made in a systematic way. Educators teach design methods to students so that they understand how to develop concepts in a systematic way and to allow them to overcome barriers in the design process, such as, when they run out of ideas.

6-3-5 is a concept generation method that is commonly taught in Product Design education [1]. The method involved 6 people, 3 ideas and a 5-minute timeframe. It is sometimes referred to as Method 635 or Brainwriting, and is a common lesson in textbooks including the Delft Design Guide [2] The benefits of 6-3-5 are the wide range of ideas generated in a short time frame and reduced impact of dominant team members on the creative ideas of students less likely to share their ideas in other brainstorming activities from a team working perspective [3].

The use of traditional design methods could be under threat by novel technologies that can replace the designer in the design process. Artificial Intelligence has been used to support creative thinking and the development of conceptual ideas [4]. Generative text-to-image AI and natural language processing AI have several applications in product design [5] including the generation of images which may be used to represent conceptual ideas, or text descriptions on conceptual ideas using these AI technologies (such as ChatGPT and DALL·E).

There is evidence within the research that methods including 6-3-5 can encourage students with less experience of concept generation to produce a greater number of creative concepts [6] and therefore

these are important tools and methods in developing basic design competencies in early design education. However, given the rise of AI, we must consider how AI could be utilised to support designers without compromising on foundation knowledge and skills' building. It is important to test these AI supported approaches in a structured educational environment before adopting as best practice [7].

This leads us to explore the possibilities of the use AI within an educational setting with the following questions:

- Can AI be used to support the creative design process of students when they have exhausted their own ideas to create novel ideas?
- Can AI be successfully used within an educational environment to support the applied learning of the 6-3-5 method?
- Can AI replace the use of creative design methods such as the 6-3-5 method within the design process?

The research detailed within this paper aims to investigate these questions and discussion is made of the appropriateness of the technology in its current developmental state.

2 METHODOLOGIES

In this section, the methodology for the design, delivery and evaluation of an experiment to assess whether AI increases novelty in the 6-3-5 method is presented.

2.1 Design & Delivery of the experiment

Twenty-eight Postgraduate students from the University of Strathclyde, studying a ten-credit module on Design Methods were asked to participate in a 6-3-5 creative method.

The class was of mixed experience with regards to design education, with some having studied Undergraduate design-based courses, and some being completely new to the field of design. To assess the base level of creativity in the room, the students were asked to score themselves on two questions. Q1. On a scale of 1-10, how creative would you say you are? (10 being highly creative). Q2. On a scale of 1-10, how would you rate your ability to think outside the box? (10 being highly capable).

As can be seen in figure 1, we had a range of experience and average 'creativity' scored 6.8/10, and average 'ability to think outside the box' scored 6.72/10.
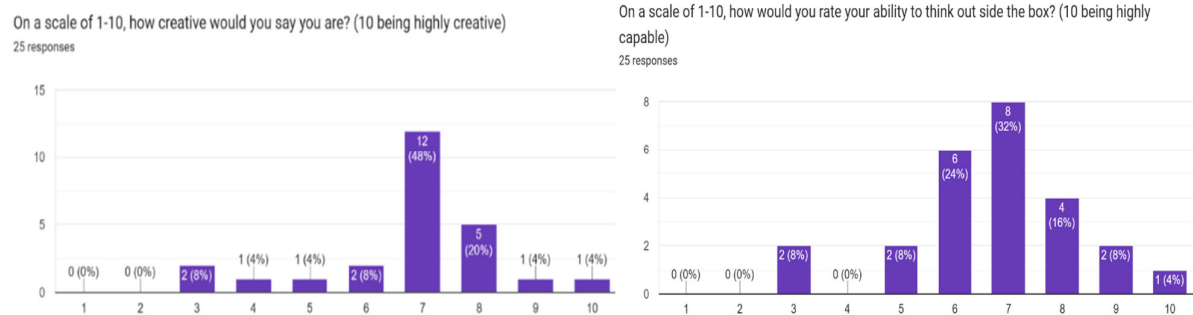

Figure 1. Student perceived 'Creativity' & 'Ability to think outside the box rating'

The 6-3-5 process was first explained to the students. The class was then divided into five groups. Due to class numbers, we had three groups of six students and two groups of five students. The groups of six would undertake a 6-3-5, and the groups of five would undertake a 5-3-5.

The scenario was set that the students were a team of product design consultants, who were tasked with developing a new product to make life easier for an arthritis sufferer when working in the kitchen. Students were asked to think and list all the challenges an arthritis sufferer may face in the kitchen to ensure they understood the problems to be addressed. Their thoughts were recorded and discussed before moving in to the 6-3-5 activity.

The students were informed they would conduct the activity in one of three approaches – either using ChatGPT for support, Google for support or no support (i.e. the control group). For the Google and ChatGPT groups, they were advised that they should only use ChatGPT or Google once they reached the point that they felt they had ran out of their own ideas. Two groups of six would be permitted to use 'ChatGPT' support (12 responses received), one group of six would be permitted to use 'Google' support

(5 responses received), two groups of five would not be permitted to use either ChatGPT or Google and were tasked with undertaking a traditional 5-3-5 (9 responses received).

2.2 Evaluation of the experiment

The experiment was evaluated using a survey, to determine at which stage ideas were exhausted, and to establish the students' perspectives on the usefulness of AI or web searching, to support the generation of novel ideas.

To investigate if the use of AI or Google web searching supported the novelty of the ideas created, a coding method and intercoder methodology was implemented. Coding would be based on a predetermined set of criteria as defined by Oman et al [8]: Usual/Unusual, Commonplace/Astonishing, Customary/Surprising, Overused/Fresh, Commonplace/Original, Common/Astonishing, Predictable/Novel and Average/Revolutionary. Each coder would determine which of these pairs of words best described the concept. The intercoder method was used to systematically conduct the coding and reduce the amount of coding required overall. Our evaluation utilised three coders. Each coder reviewed two thirds of the data overlaping with the other reviewers. All concepts were reviewed by two of the coders. Where the two coders disagreed, the third coder would decide on the coding applied. A spreadsheet was used to code the data and reveale the results. The average of each team was calculated to indicate if AI, web search, or utilising their own ideas only, resulted in novel concepts.

Novelty was selected as the measure focus on in this paper. Criteria measurments for concepts such as creativity went beyond the scope of this research, concerning aspects of the concepts such as variety, quality, quantity, appropriatness, technicality, harmony and others [8].

3   RESULTS & DISCUSSION

The results of the survey and 6-3-5 analysis are now discussed.

3.1 Survey Feedback

A feedback survey was distributed among the participants. One participant in the traditional 6-3-5 group did not respond, and one participant in the Google group and one particpant in the ChatGPT group, who did respond, are thought to have misunderstood the questions, therefore their results were removed from the analysis. Based on this, we had twenty-five responses for our analysis.

Participants were asked to inform us at what point in the 6-3-5 they felt they had ran out of ideas. As shown in Table 1, in the ChatGPT and Google groups, a higher % reported they ran out of ideas earlier in the process than those undetaking a traditional approach, perhaps due to the subconsious knowledge that when they reached this point, they could rely on external sources of AI to continue the process.

One participant in the Google group, and three participants in the ChatGPT group, reported never running out of ideas, therefore didn't use ChatGPT or Google. Their results were removed in the further analysis. This left twelve respondents from the Google and ChatGPT groups to evaluate the impact of AI.

Of the twelve participants who did utilise ChatGPT or Google, 75% reported the use of Google/ChatGPT was helpful.

Table 1. Point at which participants ran out of ideas

	Traditional	Cumulative	Google	Cumulative	ChatGPT	Cumulative
I had no ideas at all (from the start)	-	0	-	0	-	0
After round 1	-	0	1	1 (20%)	1	1 (9%)
After round 2	1	1 (11%)	1	2 (40%)	1	2 (18%)
After round 3	-	1 (22%)	-	2 (40%)	3	5 (45%)
After round 4	3	4 (44%)	1	3 (60%)	2	7 (64%)
After round 5	2	6 (66%)	1	4 (80%)	1	8 (73%)
I never ran out of ideas		*3 (33%)*		*1 (20%)*		*3 (27%)*

They were then asked to score how helpful Google/ChatGPT was in assiting them to come up with new creative ideas.Of the twelve responses, two scored 10/10. These two participants belonged to the ChatGPT group and reported running out of ideas after round 1 and round 2. Interestingly, these two participants both reported they were experienced designers, having studied four or five years of undergraduate design studies, with prior experience of the 6-3-5 method. The average' helpfulness' score overall was 3.5/10 for Google and 5.5/10 for ChatGPT.
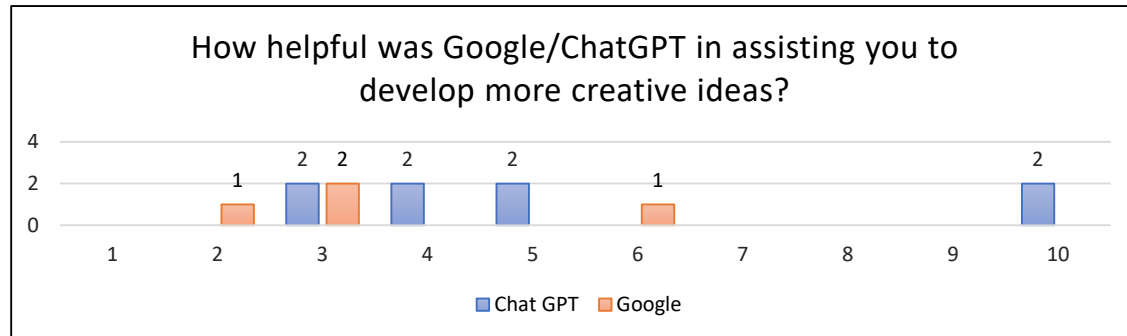

Figure 2. Perceived helpfulness of AI

An interesting observation was that those less experienced designers scored overall 'helpfulness' much lower than the experienced designers. This is an area requiring further exploration and investigation, and consideration should be given to things such as ontological, experiential or self-esteem issues of the participants, which are not considered in this study. It is hypothesised, that a reason for this could be that without the experience of having applied the method without AI, they do not see the benefits that AI can bring. This is in comparison to our more experienced designers who have been taught the method previously, without using AI, and therefore have their prior experience for comparison.

3.2 Intercoder Analysis

The results of the intercoder analysis are now shown. The results demonstrate that those in the ChatGPT and Google groups came up with more novel ideas than those undertaking the traditional approach (scores closer to 0 indicate higher novelty).

Therefore, we can say that, in the study, the use of AI in the 6-3-5 method does increase the novelty of concepts being generated by the students. Therefore, the use of AI can be implemented with digital 6-3-5 design tools [8].

To answer our research questions:

- Can AI be used to support the creative design process of students when they have exhausted their own ideas to create novel ideas?

Table 2. Results of Intercoder Analysis

	1	2	3	4	5
	ChatGPT	ChatGPT	Google	Control	Control
Group Average	-2.33	-3.89	-2.89	-5.06	-4.33

To answer our research questions:

Can AI be used to support the creative design process of students when they have exhausted their own ideas to create novel ideas?

Yes, these technologies can be appropriately used as per this context. However, we must consider that there is evidence, as shown in Table 1, that students may use the technology so that they do not have to put in as much effort as they otherwise might in creating their own novel ideas. This supports the idea that AI can be used as inspiration within the design process but perhaps should not be used to generate initial concepts [9] with more novice designers.

- Can AI be successfully used within an educational environment to support the applied learning of the 6-3-5 method?

Yes, AI can support the applied learning of the 6-3-5. From our results it is suggested that AI integration to support the 6-3-5 is most successfully implemented with more experienced designers and should be taught after students have some experienced of applying these methods without AI.

- Can AI replace the use of creative design methods such as the 6-3-5 method within the design process?

Yes and no. Our research suggests that ideas generated with the support of AI were more novel than those without, and this therefore suggests that educators can implement AI for idea generation. However, the perceived helpfulness of AI was not fully appreciated by novice designers (as shown in figure 2) therefore there could be a greater challenge to overcome for novice designers if they do not learn to apply the method themselves in the first instance.

3.3 Limitations and Future Work

The limitations of this study are in the sample size. Backgrounds of the participants is also not explored in detail, other than number of years design experience. Consideration could be given to ontological, experiential and self-esteem of the participants to further understand why more notice designers viewed AI as less helpful than those more experienced designers. The intercoder methodology has been proven as reliable for this research investigation and should be followed for any repetition of the findings. Research, across similar classes and other institutions can test these findings across further similar classes and institutions. This research may expand to determine if aspects beyond novelty can be coded and conclusions made.

4 CONCLUSIONS

The results of the study indicated that when using AI to support idea generation, students are more likely to rely on the technology before fully exhausting their own ideas. The generated concepts were more novel when AI (ChatGPT or Google) was used, however an interesting observation was that the perceived helpfulness of the AI approach was lower with the more novice designers.

In summary, AI can be successfully used to support the applied learning of the 6-3-5 method, and it can be used to support the creative design process of students when they have exhausted their own novel ideas. However, we need to keep in mind that students may not put in as much effort as they otherwise might in creating their own novel ideas when AI is available. On the question of, can "AI replace the use of creative design methods such as 6-3-5 within the design process?" Our early research indicates that AI does have perceived benefits to more experienced designers and does achieve more novel concepts, however in our novice designers, there still needs to be a foundation appreciation of a method without the use of AI to see its benefits.

REFERENCES

[1] Nutzmann M., Sauer T., Voß M., Bozkurt H. et al. Survey on learning concepts applying creativity methods in education and industry. *DS 95: Proceedings of the 21st International Conference on Engineering and Product Design Education (E&PDE 2019),* University of Strathclyde, Glasgow 12th-13th September 2019 pp.568-573.

[2] van Boeijen A., Daalhuizen J., van Der Schoor R. and Zijlstra J. 2013. *Delft design guide: Design strategies and methods*. BIS Publishers.

[3] Litcanu M., Prostean O., Oros C. and Mnerie A. V. Brain-writing vs. Brainstorming Case study for Power Engineering Education. *Procedia-Social and Behavioral Sciences*, Elsevier. 2015, 191, pp.387–390.

[4] Sosa R. and Gero J. S. Multi-dimensional creativity: a computational perspective. *International Journal of Design Creativity and Innovation,* 2016, 4(1), pp.26–50. https://doi.org/10.1080/21650349.2015.1026941

[5] Brisco R., Hay L. and Dhami S. Exploring the role of text-to-image AI in concept generation. In: *Proceedings of the Design Society.* 3: pp.1835-1844, 28 June 2023.

[6] De Napoli L., Rizzuti S. et al. Product design education in mechanical and management engineering master's degree programs: Analogies and differences. *DS 104: Proceedings of the 22nd International Conference on Engineering and Product Design Education (E&PDE 2020),* VIA Design, VIA University in Herning, Denmark, 10th-11th September 2020, pp.361-366.

[7] Beetham H. and Sharpe R. Rethinking pedagogy for a digital age: principles and practices of design (3rd ed.). 02019. (Routledge). https://doi.org/https://doi.org/10.4324/9781351252805

[8]   Oman S. K., Tumer I. Y., Wood K. and Seepersad C. C. A comparison of creativity and innovation metrics and sample validation through in-class design projects. *Research in Engineering Design* 2012. 24, pp. 65-92. https://doi.org/10.1007/s00163-012-0138-9

[9]   Brisco R., Grierson H. and Lynn A. Lessons learned in the development of an online 6-3-5 digital design tool for distributed idea generation. In *DS 110: Proceedings of the 23rd International Conference on Engineering and Product Design Education (E&PDE 2021).* Grierson, H., Bohemia, E. & Buck, L. (eds.). Glasgow, 10 Sept 2021.