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GROUP IDEATION WITH BRAINWRITING – A COMPARISON OF CO-LOCATED AND DISTANCE COLLABORATION

Markus VOß[1], Hulusi BOZKURT[1], Thorsten SAUER[2] and Marc NUTZMANN[2]
[1]DHBW Cooperative State University Mannheim, Germany
[2]DHBW Cooperative State University Ravensburg, Friedrichshafen, Germany

ABSTRACT
This article examines the influence of physical proximity (co-location vs. distance) and the medium (paper vs. online) on idea generation. It especially focusses on a popular brainwriting technique – namely Method 6-3-5. For this, an experiment with altogether $N = 134$ Engineering Design students was conducted. The results show that the mode of interaction generally does not bias the quantity of ideas generated, but that the rate of graphical representations drops slightly.

Keywords: Creativity, idea generation (Ideation), conceptual design, brainwriting techniques (Method 6-3-5), distance collaboration

1 AN UNFORESEEN CHANGE IN COLLABORATION
During the coronavirus pandemic, the modes of collaboration in the working world in general and of engineers and product developers in particular drastically changed. Also in academia, all actors faced a hitherto unparalleled challenge. From literally one day to the next, confinement regulations urged many learners and educators to switch over from conventional classroom teaching to unexplored online formats. This article studies the role of idea generation under these changed circumstances.

2 METHOD 6-3-5, A COMMONLY USED BRAINWRITING TECHNIQUE
Idea generation takes place in the early phases of design and is crucial for the rest of the process. Numerous techniques have been developed for structuring idea generation. This article concentrates on a popular technique for brainwriting – called Method 6-3-5 – which dates back to the end of the 1960s and which is attributed to Rohrbach [1].
The digit sequence 6-3-5 gives the method a telling name that refers to how it should be implemented, see Figure 1: The method is designed for $n = 6$ group members, usually gathered physically round a table. Each of the participants receives a printed form. The worksheet mainly consists of a table (with $n = 6$ rows and $c = 3$ columns). In the first iteration, every participant looks individually for $c = 3$ solutions. The three developed solutions should be described in the first row of the table. Each solution thus fills one field. In the most current interpretation, the number 5 in the name of the method contains a recommendation for how long this individual working phase should take – namely 5 minutes. The moderator (or a designated group member) should assure timekeeping and make corresponding announcements, cf. [2].
Then the form is handed over to the next group member, e.g., clockwise. During the whole session, the group members should not change seats, and neither alter the order nor the direction in which the forms are passed on round the table. Now, each group member develops further three solutions and describes them in the second row of the table. After every five minutes, the forms are passed to the next person in the round until all six rows of the form are filled with solutions.
The complete turnaround thus takes just half an hour. Considering the short amount of time it needs, Method 6-3-5 leads to a particularly high number of solutions. One could say that scarcity of time creates ‘creative stress’. Amabile et al. [3] call that phenomenon ‘creativity under the gun’. The maximum number of distinct solutions that a group can create during a brainwriting session corresponds to the total number of fields on the worksheets. Thus, the $nc = 6 \times 3 = 18$ fields on $n = 6$ worksheets

contain up to $n^2c = 108$ solutions (if all fields are completed, of course). Another inherent advantage of that brainwriting method is that it does not consume any extra time for documenting the solutions.

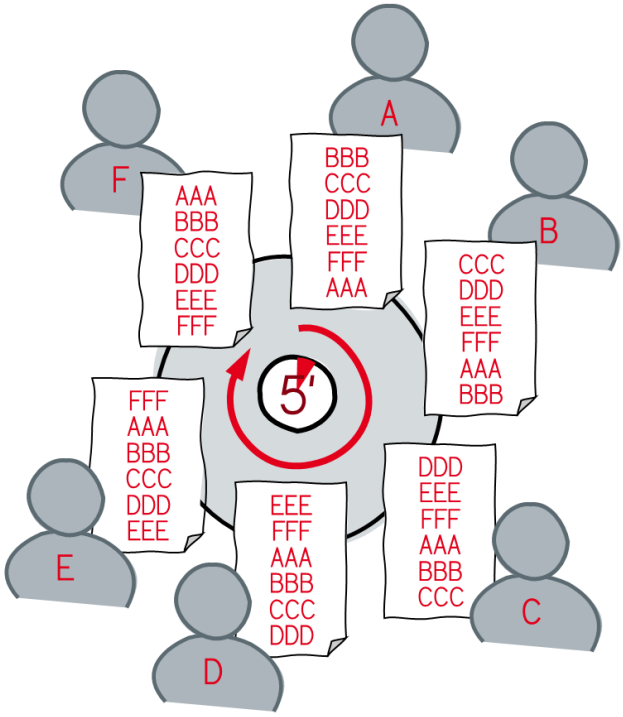


*Figure 1. With help of Method 6-3-5 **six** group members generate **three** ideas each within **five** minutes per round*

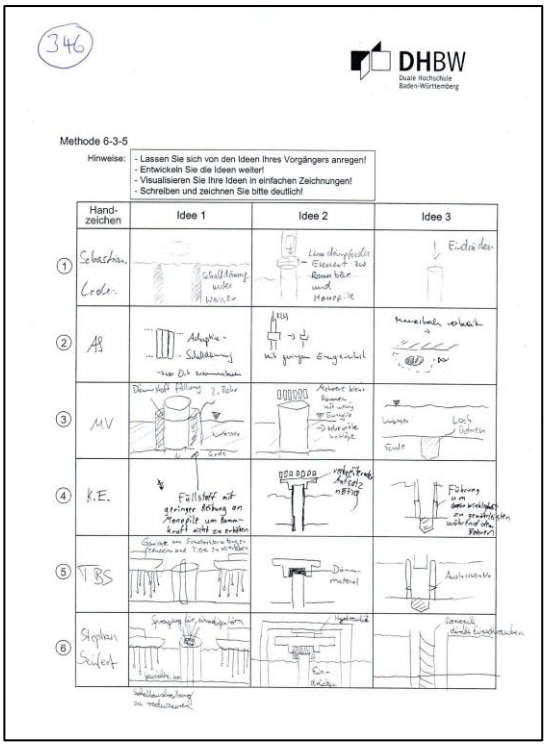


Figure 2. Fully completed brainwriting paper form from the workshop

When receiving a form sheet, every group member is free to feel inspired by the solutions already described above. In this way, the solutions can be refined bit by bit. Ideas can be picked up by others, developed further, seen under changed conditions, be complemented, sectioned, parallelised and even inverted. On the other hand, there is no obligation to bear associations to the ideas of others in mind when formulating new ideas. If desired, simply a new idea can be introduced.

Of course, creativity cannot be maintained endlessly. It is reported that the idea productiveness in creativity workshops already drops noticeably after a quarter of an hour, see Figure 3. Typically, participants collect rather conventional ideas during that first wave. If a workshop uses other creativity techniques that require an experienced moderator, a decline in the frequency in which participants utter their ideas is often an indication for a new impulse should be set. But interventions of that kind would rather interrupt the workflow when working with Method 6-3-5. Inspired by Yilmaz et al. [4] we experimented in previous research [5] instead if heuristics can serve as 'cognitive shortcuts that encourage exploration of novel directions. The current experiment is interested in exploring how this characteristic evolves without such an intervention. Interestingly, the time needed for a complete turnaround in Method 6-3-5 coincides with the moment where finally creativity drops drastically (after – according to experience – innovative solutions were created in a second wave), as also depicted in Figure 3.

In contradistinction to conventional brainstorming where associations are uttered freely (and sometimes at top of the voice), Method 6-3-5 is a rather 'silent' creativity technique, see Figure 4. This comes in handy for 'taming' dominant participants and for encouraging persons that are more withdrawn. This combination of collaborative and individual elements of working within one technique is broadly seen as a major advantage of Method 6-3-5. It is also said that, compared to 'jumpy' and 'whirling' discussions in brainstorming sessions, participants work far more systematically with this brainwriting technique. The other side of the coin is that Method 6-3-5 for sure engenders less 'creative dynamics' in the workshop since the group members do not interact directly but just in the writing process.

Another disadvantage of the method is that fields left empty at the top by a team member tend to 'propagate downwards' in the worksheet since the succeeding team-mates have less rich inspiration. 'Empty fields are contagious', can be concluded.
Finally, an obvious but imposing advantage of Method 6-3-5 in design-related disciplines is that its format allows visualising ideas in simple annotated sketches. This obviously supports visual communication, provided that all participants write and draw clearly, of course.

3 EXPERIMENTAL APPROACHES

Is the finding of creative solutions in a virtual environment as easy as in co-located workshops? In order to find out how important physical proximity (co-location vs. distance) and the medium (paper vs. online) are in the field of ideation, we conducted an experiment. We embedded the experiment in our Engineering Design lecture taught in the fifth semester of our three-year Mechanical Engineering bachelor's programme at DHBW Cooperative State University.
Altogether $N = 134$ Engineering Design students participated in the experiment. $N = 78$ of them gathered in a common classroom setting and worked on paper forms. The workshops took place during the pre-Covid academic years 2016 to 2019 and four cohorts with altogether 13 groups were engaged. The size of most of the groups was six, as preferably required for Method 6-3-5. But as the division in groups did not always come out even, a few groups consisted of four, five or seven students. Figure 2 shows an exemplary paper form, filled in manually by a student work group during the workshop.

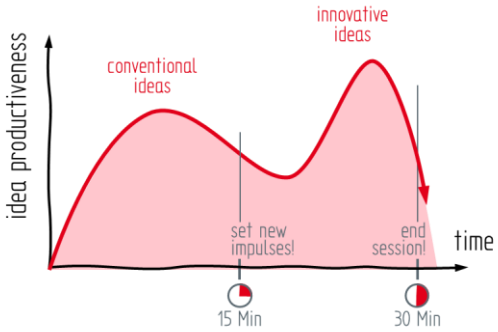


Figure 3. Typical characteristics of the idea productiveness during creativity workshops

Figure 4. Method 6-3-5 reconciles individual with collaborative ideation

The experiment was repeated in the academic year 2020 when no presence gathering was possible. The $N = 56$ students of that cohort had to collaborate in a virtual environment. The students were split up into ten groups. Seven had the ideal group size of six participants, but for the known reasons two groups were made up of five and one of four students respectively. For the workshop we prepared digital worksheets in a browser-based online collaboration whiteboard tool named Conceptboard [6], see Figure 5. Apart from the collaboration mode, the virtually collaborating study group worked under the same conditions as the one gathered in situ. The brief for the workshop was unchanged.
It is a common misunderstanding that people can be more creative if they are told as little as possible about a problem. Brem [7] maintains the contrary: 'As a rule of thumb, the more specific the question, the higher the chance for concrete and directly usable ideas.' Therefore, the problem was framed adequately in a design brief. The experiment confronted students with a real-world large-scale application: a research platform on offshore wind farms in the North Sea and the Baltic that rests on a monopile, cf. [8]. The group assignment asked the students to explore innovative noise abatement measures to prevent marine mammals (mainly porpoises) being harmed by ramming the monopiles 30 metres deep into the seabed during construction, cf. [9]. During the interventions, the students were not told about the solution applied in the real project.

4 RESEARCH QUESTIONS

For studying if an alteration of the way in which the workshop participants meet (co-location vs. distance) and on which medium they communicate (paper vs. online) influences the ideation process the study in hand investigates more specifically the following research questions:

(Q1) Does idea productiveness drop when the participants are physically isolated?
(Q2) Does the change of media influence the repartition of textual and graphical representations?
(Q3) How does idea productiveness evolve during the workshop time?

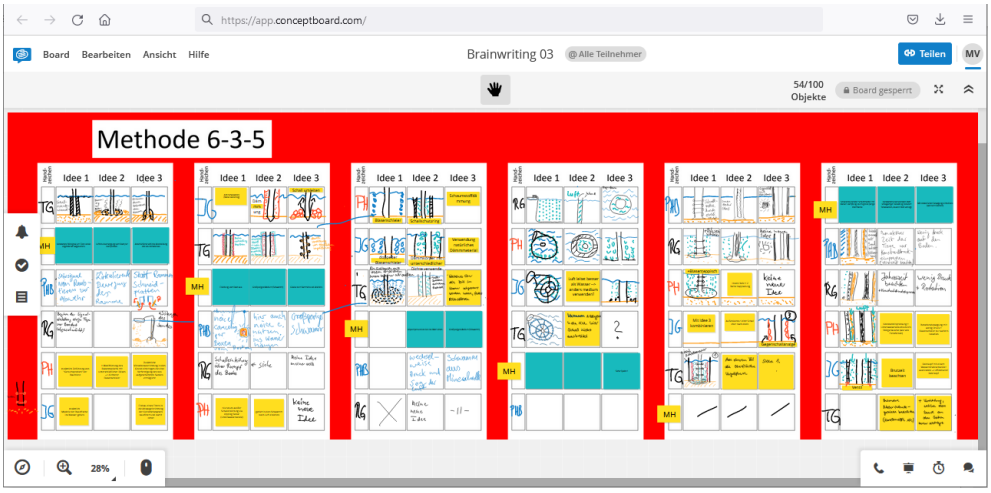


Figure 5. Brainwriting in the online collaboration tool Conceptboard [6]

5 RESULTS

The presented research is based on a close inspection of the worksheets produced in the experiment and is using quantitative metrics. For analysing if idea productiveness has been affected, the number of fields $\bar{x}$ left empty and the number of fields x completed were counted on the n worksheets of a group.

$$\bar{x} + x = n^2 c = 108 \tag{1}$$

If the group size deviated from the standard group size $n' \neq n$, the field count ($\bar{x'}$ signifying empty fields and x' completed fields) had to be normalised correspondingly by the correction factor $(n/n')^2$.

$$(\bar{x'} + x')(n/n')^2 = n^2 c = 108 \tag{2}$$

For displaying how many fields the groups left empty and completed respectively, the corresponding numbers $\bar{x}$ and x were related to the total number of fields $n^2 c$, see Figure 6. From the results, it can be concluded that the alteration in the mode of interaction and change in the medium did not affect idea productiveness. In average the paper-based working groups that gathered in presence completed $\mu_{x/n^2 c} = 84$ % of the worksheets and the virtual meeting groups using the digital tool even a bit more (86 %). With a standard deviation $\sigma = 11$ % the results from the group working on paper 'scattered' marginally more than those from the group working digitally ($\sigma = 7$ %) but were still comparable.

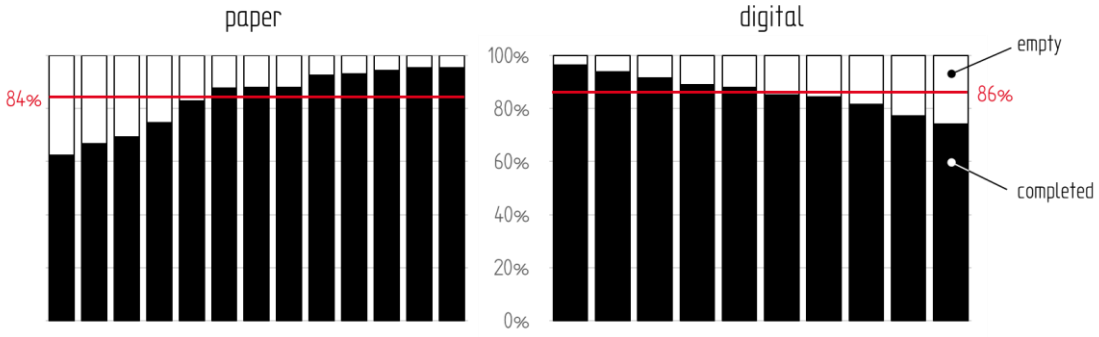
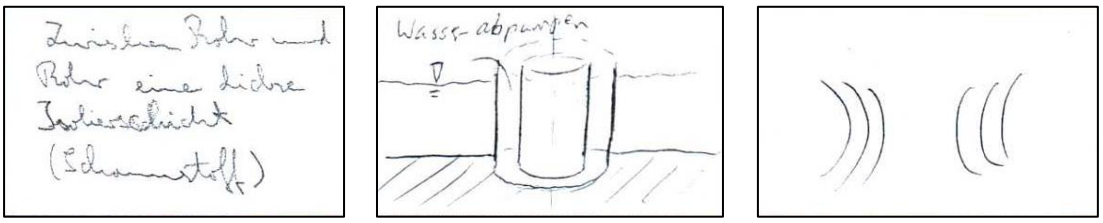


Figure 6. Distribution of the empty and completed fields on the worksheets as a measure for idea productiveness

For measuring if the amount of pure textual description has increased with the switch to digital tools, all worksheets were re-examined and the number of fields t containing textual and g graphical elements was counted, cf. Figure 7. Annotated drawings that blend graphical representations and textual

descriptions were accounted as graphics. As a relative measure, the respective field count (normalised if necessary) was related to the corresponding number x of non-empty (i.e., completed) fields.

$$t + g = x \tag{3}$$



(a) (b) (c)

Figure 7. (a) Textual description, (b) annotated drawing and (c) graphic from students on paper worksheets

On the digital whiteboard, different types of text production were encountered, see Figure 8. Some students (a) used the available text editor in the web-based tool, while others (b) improvised and wrote with the computer mouse or could – if they owned tablets or notebooks with tactile displays – (c) write directly by hand. All three of them have been classified as pure text in the examination.

(a) (b) (c)

Figure 8. Text production (a) using text editor, (b) written with mouse and (c) handwritten on the virtual collaboration whiteboard Conceptboard

The results revealed that, compared to paper based-work, digital tools increased the use of textual elements by around 9 %. While on paper an average of $\mu_{t/x} = 40$ % text fields was found, it was 49 % on the digital whiteboard. An obvious reason for this deviation is that not every student had a suitable graphical input device (e.g., a notebook computer with a stylus pen) within reach in this impromptu workshop.

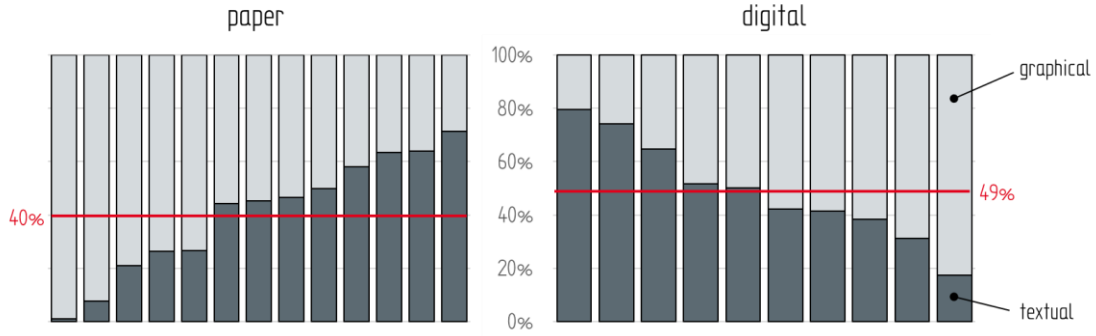


Figure 9. Use of textual and graphical representations in the experiment

To find out how idea productiveness evolved over the duration of the workshop, a further examination counted non-empty (i.e., completed) fields. Since every row $\forall i \in [1, n]$ corresponds to a time interval $t_i = (i - 1, i]5$ min, the field count was split up row-wise (again normalised for non-standard groups). As a result, the characteristic curve in Figure 10 is nearly identical for both study groups (paper and digital) over time. Nevertheless, contrary to the expected characteristics described in literature, cf. Figure 3, the diagram does not exhibit any significant 'rebound effect' in the second half of the

timeline. Instead, the curves decline steadily from around 95 % during the first to 72 % during the last time interval.
Whereas interpreting the ‘resurgence of ideas’ in a qualitative way, this study can partially validate this expected characteristic. Because interestingly, some teams managed to develop a solution that comes close to the one applied in the real-world project. The latter attenuates the noise with help of a ‘bubble curtain’ around the monopile sprayed from a ring-shaped pipe installed on the seabed, cf. [10]. In all three cases where the evolution of ideas led to a bubble curtain-like solution, the decisive idea appeared in the second half of the workshop.

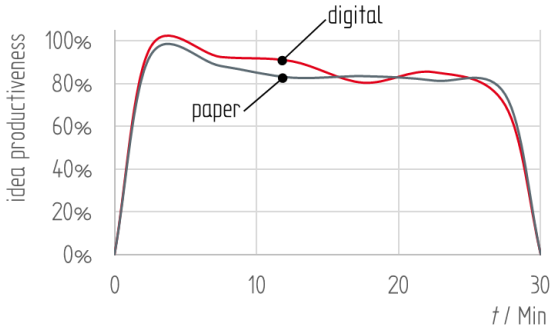


Figure 10. Experimental findings on the idea productiveness during the brainwriting sessions

6 CONCLUSIONS

With our experiment we could prove that – seen from a quantitative angle – participants are equally productive in a brainwriting workshop regardless of their mode of collaboration (co-location vs. distance) and their medium of communication (paper vs. online). At the same time, we observed a drop of graphical representations of about 9 % in online meetings. Which is nonetheless highly remarkable, since our students neither have been trained at length using the online tool nor have been equipped with special graphical input devices. Regarding the quantitative evolution of idea productiveness during the 30-minute workshops we could not confirm the hypothesis from literature assuming that idea productiveness rises to an even higher level after decreasing temporarily towards the half of the workshop.

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