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How to make brainstorming and idea screening learning more effective

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Abstract: Brainstorming is commonly taught as a of part innovation courses and various rules have been suggested for gaining better outcomes. Typically brainstorming is executed as an interactive group activity. However, some studies argue that better results in terms of number of generated ideas can be achieved by using individual creativity, so-called nominal group approach. In an educational context individually performed tasks are more easily to assess and they are also immune to the various known problems of student group work. Therefore, this study combines guidelines how experimental brainstorming learning setting should be applied and could be varied while noting the known pitfalls of brainstorming and student assessment. Second, since idea quantity can also breed quality, we tested if the greater number of ideas is leading to a higher idea quality. Experimental learning setting with a student group (N=114) verified that idea quantity is helping only on the later stages of idea screening.

Keywords: brainstorming, learning, idea screening, nominal group, interactive group

1 Introduction

It has been argued that in order to generate one commercial successful innovation, thousands of raw ideas are needed (Stevens and Burley, 1997). Importantly new knowledge and creativity always starts from individual efforts which later on can be transformed into valuable organizational knowledge to contribute organizational innovation (Nonaka, 1991). Thus, a solid number of ideas on the early phase of innovation process (Cooper, 1988) also known as a fuzzy front end (FFE) of innovation (Smith and Reinertsen, 1991) are important from individual and organizational point of view. Different variations of FFE models appears to have somewhat similar activities (Jetter, 2003) including stages from the idea generation to decisions on further development (Murphy and Kumer, 1997). Various practical methods for FFE have been proposed, yet brainstorming is clearly among the most well-known (Osborn, 1963). Ferrari et al. (2009) provided an overview of the theoretical foundations for strongly interrelated creativity and innovation concepts in the context of education. According to their report, unlocking the creativity and innovative potential of the young people would require both innovative practices of teaching for creativity and also of applying innovation to teaching. Therefore novel learning approaches grounded on a strong theoretical foundation while helping to generate novel ideas more effectively and select the best ones are most welcome. As a result in this study our goal is to define preliminary framework and guidelines for experimental brainstorming learning process and shortly summarize the related pitfalls of brainstorming.

This paper is organized as follows. *First*, we will introduce the body of knowledge regarding brainstorming, how intrinsic and extrinsic motivation influence learning and student assessment from group and individual point of views. *Second*, typically brainstorming is executed as an interactive group activity although better results in terms of number of generated ideas can be achieved by using individual creativity, so-called nominal group approach. However, mixed results regarding quantity ability to breed quality has been presented (Rietzschel, 2005). Thus, we will empirically test if the greater number of ideas is leading to a higher idea quality in context of nominal student group experiment. *Lastly*, we conclude our findings and suggest further studies to verify our assumption on brainstorming learning in educational context.

2 Theoretical background

2.1. Brief introduction to brainstorming

In 1950s Osborn (1963) developed the brainstorming method for creating advertising campaigns. Since then brainstorming has been applied in various domains in industry and it is commonly taught and used as a part innovation and development courses. Brainstorming has been defined as a specific procedure for idea generation, with specific rules (Osborn, 1963; Rietzschel, 2005). A number of rules have been defined for proper implementation of brainstorming process including such as (Furnham, 2000) 1) group size limited from five to seven, 2) not allowing criticism, 3) encouraging freewheeling, 4) avoiding over-structuring, 5) taking notes during the session, 6) emphasising quantity and variety, 7) building on the ideas of other by combining and improving them and 8) later on edit, categorize and select the best ideas for possible implementation. From educational context point of view it is noteworthy that brainstorming as well as FFE includes not only the idea generation but also the idea selection, which is known also as idea screening (Toubia and Florès, 2007). However, the existing brainstorming and creativity literature has mainly focused on the idea generation process while the body of knowledge regarding selection process is clearly less representative (Girotra et al., 2010). Recent study by Hammedi et al. (2011) proposed some guidelines for idea screening teams to improve their decision making abilities including such as stimulating openness and argument based discussion, allowing team member to a stop-and-think, and adapt available tools and models only when they are needed.

2.2 Which brainstorming process is most effective and why?

Most typically brainstorming is implemented as a group activity and it is commonly incorrectly assumed that interactive group brainstorming is more effective than "nominal group" approach i.e. individuals performing first in isolation with no interaction and whose productivity is later on combined (Stroebe et al.1992; Paulus et al. 1993). Productivity aspect is important in brainstorming, since idea quantity can breeds quality (Osborn,1963) and in fact a long stream of studies have shown that nominal groups outperform interactive groups in terms of number of generated ideas (Mullen et al. 1991; Girotra et al., 2010). Evaluation apprehension, social lofting also known as free riding and productivity blocking are typically offered as a reason for inferior performance of interactive groups (Diehl and Stroebe 1987). Despite of this, interactive brainstorming remains a popular approach since most individuals believe that they generate more ideas in a group than alone, maybe partly due the possibility of social comparison in group brainstorming and a tendency to appropriate others ideas (Paulus et al. 1993). However, interactive group better performance assumption is misleading also from idea quality point of view, because common brainstorming technique of building on others' ideas is found to be counterproductive in terms of quantity and quality (Girotra et al., 2010). Furthermore, although nominal groups are able to generate more and better ideas, their ability to identify and select the best ideas is not always better comparing to interactive group (Rietzschel, 2005) even if some studies have found support for nominal groups better ability to assess the quality of ideas (Girotra et al., 2010). Hence, a nominal group is not necessarily able to make use of their better starting point comparing to interactive group.

Besides the interactive vs. nominal group composition, the generic structure of brainstorming process can also effect on the brainstorming outcome. For example instructions before brainstorming session focusing on the quantity of ideas can significantly enhance productivity comparing to situation when participants do not receive such instructions (Shalley, 1991). Moreover comparison studies between quantity vs. quality focus of brainstorming instructions have resulted mixed outcomes, yet some recent studies argue that the quantity instruction is most beneficial strategy for brainstorming (Paulus et al. 2011). Noteworthy if idea generation and selection are presented as one task especially for interactive group, they generate fewer ideas than if idea generation and selection presented as two separate tasks (Rietzschel, 2005).

2.3 Intrinsic and extrinsic motivation influence on learning

Personal and contextual characteristics are known to influence on the creativity of individuals (Shalley et al. 2004). It is also known that besides instructions and assessment tools, learner's personality, cognitive style and academic abilities are influencing on learning results and learning process (Hogle, 1996; Bredemeier & Greenblat 1981; Dempsey et al., 1993; Gardner, 1983; Jacobs & Dempsey, 1993; Seginer, 1980). Therefore in the case of brainstorm learning, it would be especially important to provide opportunities for multiple learning styles and different kind of learners (Fontana et al., 1993; Smith, 1992; Turner & Dipinto, 1992; Wilson, 1991). A series of studies (Deci and Ryan 1985; Lepper and Chabay, 1985; Middleton and Toluk, 1999) indicate that motivation to learn depends upon a complex mix of intrinsic and extrinsic factors. Intrinsic motivation (e.g. Utman, 1997) – a tendency to engage in activities for their own sake, just for the pleasure derived in performing them or for the satisfaction of curiosity (Covington and Müeller, 2001), without any external reward or punishment (Malone and Lepper, 1987) – is one of the most important factor relating to learning and it is also strongly linked to creativity (Amabile, 1998). Extrinsic motivation on the contrary refers to doing something because it leads to a separable outcome (Ryan and Deci, 2000) such as compliance, recognition, and grades and rewards (Covington and Müeller, 2001).

Unfortunately all students are not equally intrinsically motivated and the level and the orientation of motivation most likely vary among the brainstorm lecture participants. Easy to apply methods to measure the level of intrinsic motivation includes self-reports of interest and enjoyment of the activity per se (Ryan and Deci, 2000), task-specific

(Ryan, 1982) or general measures such as one's intrinsic motivation for school (Harter, 1981). Moreover, academic motivation positively influences academic performance (Fortier et al. 1995). Therefore selecting and grouping students on the basis of their preceding academic performance or self-reporting motivation, should be noted when planning brainstorming experiment.

2.4 Brainstorming assessment

From teacher's point of view, individually performed tasks are technically more easily to assess, than interactive group works. Individual student work is also immune to the possible motivation problems of group participants and other common problems relating to student group work (Davies, 2009). Since most typically in working life context brainstorming is a group work, student should have a possibility to experience group based brainstorming. Group based learning is widely accepted and effective learning approach, which undoubtedly have also many advantages (Gatfield, 1999). Furthermore, idea screening stage also opens a natural door for peer assessment, which has been considered as a reliable and valid approach (Topping, 1998). The different compositions of the groups are influencing in many ways to student group performance such as reflecting the ability of the most able group member (De Vita, 2002). As a result, group based brainstorming in the case of idea generation and screening is highly welcome approach, if teacher is paying serious attention to grouping process when planning brainstorming experiment. It is recommended that students would have a possibility brainstorm with differently composed groups.

2.5 Guideline for teaching brainstorming

As presented above teachers should make a conscious decision relating the different options to carry out brainstorm learning session such as a) whether to use interactive vs. nominal group approach, b) how to form student groups, c) when and what kind of instructions and task orientation are given for student before starting and during the brainstorming session and d) paying equal attention also to idea screening stage and not only emphasising the importance of idea generation stage. To unlock the creativity and innovative potential of the young people as proposed by Ferrari et al. (2009), students should gain skills to carry out brainstorming processes and understand how the different options might influence on the brainstorming outcomes.

Following experiential learning definition by Kolb (1984) *learning is a process whereby knowledge is created through the transformation of experience*. Therefore the focus in brainstorming learning should be in the process itself instead of outcomes while highlighting the iterative nature of learning and creativity. Agile methodologies (Beck et al. 2001) derived from software development such SCRUM (Schwaber, 1997) might offer a kind of benchmark also for brainstorming teaching due the iterative and repetitive process nature. As a result we encourage teachers to conduct different variation of brainstorming processes in order to provide student possibilities to discover experimentally how the different process variations can influence the outcomes.

3 Research design for experimental learning setting

As a result of the previously presented theoretical considerations we are assuming that in a nominal group brainstorming *the greater number of generated ideas is enhancing student chances to pass his/hers ideas through subsequent interactive idea screening process when it is conducted by group of student peers*. In order to test this hypothesis, the data collection process with a nominal bachelor student group (N=114) included following three phases: 1) task orientation for students, 2) idea generation individually and 3) idea screening within the student group.

First, to make ideas comparable, the topic was predefined. Edutainment (Addis, 2005) – a diffusion of education and entertainment – and gamification (Pedersen 2003) – the concept of applying game-design thinking to non-game applications to make them more fun and engaging – were selected as suitable topics. This topic was selected since all students should have extensive experience on education, entertainment and games, thus making the starting point for the idea generation as equal as possible to everybody. Before starting the actual idea generation, the key terms definitions and practical examples were shortly presented to students.

Second, the guidelines for idea generation were introduced highlighting the idea quantity (Paulus et al. 2011) and students were asked to write at least 15 edutainment or gamification ideas by themselves. To motivate students, it was stated that 50 per cent of the grade of given lecture depended on this particular task. The aim of this guideline was to create more stressful working environment for students while trying to simulate more working life oriented situation in which your idea generation skills can effect on your rewards. At this stage due the possibility of productivity loss caused by social inhibition or other group based factors (Rietzschel, 2005), no information was given relating to the forthcoming idea screening process as a group. To increase the stress even more, student had only 10 minutes to finish the task. This could assumable lower student's intrinsic motivation and creativity. In all we were aware that some of our learning setting choices such as tight timeline, measuring individual performance and performance linkage to grade could increase the idea quantity thus assumable also the quality, while other choices could decrease them. Anyhow our experimental learning setting was identical to all participants and the experiment therefore itself should not cause any bias.

Third, about an hour lecture covering various idea definitions, classifications and examples of innovations and ideas was given to student in order to create a critical foundation for the idea screening phase. The follow–up phase was called "selecting the best ideas for further development". In this process phase students shortly presented their ideas to the other group members and tried to convince them of the goodness of their ideas. Basically they were trying to pitch their own ideas to the other group members in a way that their idea would be selected instead of some other ideas. During this interactive phase, the each student group had to select the three best ideas for the further development. In all 114 students participated to the first idea generation phase, but only 100 students participated on the idea screening task. Furthermore, a detailed analysis of group work revealed few groups did not fully finish the task as guided and therefore they were omitted from the analysis. All together our final data set included 74 students in 15 groups each having either 4, 5 or 7 members.

4 Findings

4.1. Descriptive statistics: Students ability to generate and promote ideas

About idea quantity. In the figure 1 we have presented a frequency distribution of the number of ideas generated by students a) individually and b) as a combined summary for total number of ideas for each idea "number of ideas group".

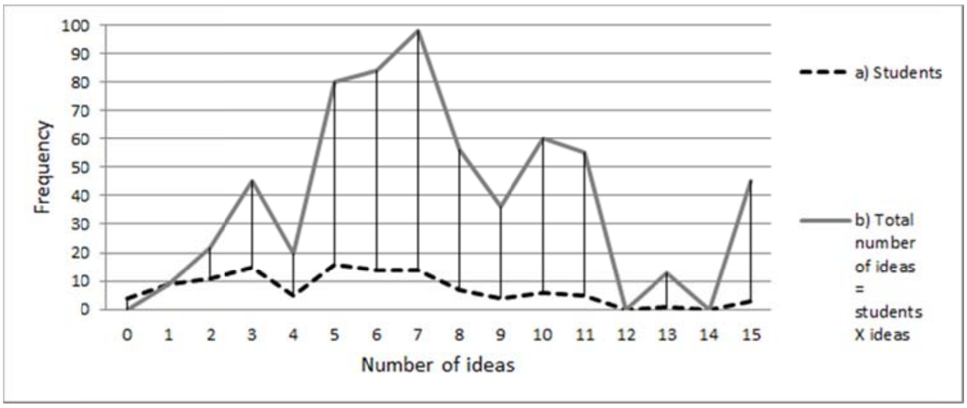

Figure 1 Frequency distribution of ideas generated by a) each student and b)

On the average student generate 5.46 ideas and the standard deviation in our data set was 3.36 ideas. About 80 percent of the student generated from 1 to 8 ideas. Four students (2.51 percent) were not able to generate ideas at all and only three students (2.63 percent) were able to achieve the required fifteen ideas limit. Together these two far-end groups represented 6.14 percent of the whole student group. These results reveal that student performance clearly varied during the idea generation phase.

About idea quality. In the figure 2 we have presented the frequency distribution of number of selected ideas from student point of view. Over half of the students (55 percent) were not able to successfully promote their own ideas during the idea screening process. Most of the remaining students (ca. 40 percent) were able to pass one idea. Only five students (ca. 4 percent) succeeded to pass two ideas and only one student was able to promote three ideas. Thus in a student group it was very difficult to pass more than one idea through the screening process. These results reveal that student performance and assuming idea quality clearly varied in the idea screening phase.

As an overall result we had a heterogeneous group of students and their ideas which were varying in terms of quantity and quality.

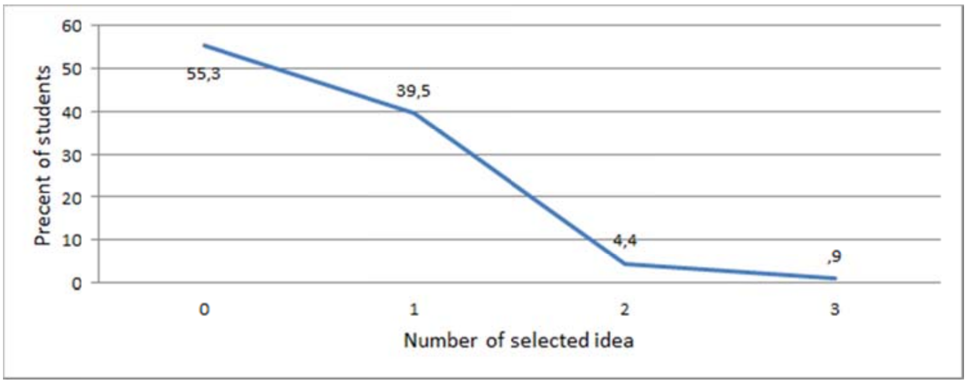

Figure 2 Frequency distribution of number of selected ideas by students

4.2 Descriptive statistics: Students ability to generate and promote ideas

The follow–up idea screening phase required a formation of student groups. The lecture hall where the experiment occurred was rather large and we did not have exact prior knowledge about the number and names of the participating students. Therefore students were guided to quickly form five-person groups with nearby fellow students for the purpose of idea screening phase. Due the short time window and difficult movement between different bench rows, actually we end-up having a total of 15 groups which in all included 74 students. Of these fifteen groups, 3 groups had 4 members, 11 groups had 5 members and 1 group had 7 members.

In the figure 3 we have presented the frequency distribution of number of ideas per group.

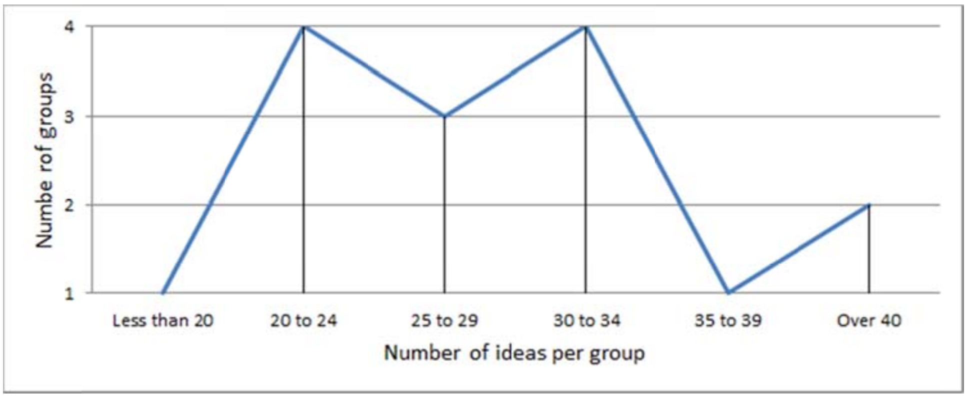

Figure 3 Frequency distribution of number of ideas per group

On the average student groups had 29.36 ideas to choose from, while the standard deviation was 7.57 ideas. Minimum number of ideas per group was 16 and maximum 45 ideas. Nearly three-quarters of the groups had from 20 to 34 ideas to choose from.

4.3 Testing the possible bias errors from grouping procedure

In order to test the possible bias errors from our grouping procedure, following analysis were conducted. Number of students with in a group correlated positively with the number of ideas within a group (0.370, sig. 0.001). Basically this meant that if there were more students in a group, then a group had more ideas to select from. This result is very logical. Moreover, idea count per student correlated with the number of ideas in the group (0.393, sig. 0.001) but not with number of students in the group. These result indicated unbiased grouping, since the composition of the groups were randomly varying in terms of how many students were included and how many ideas group members had generated in a previous idea generation phase. Finally, since students tend to sit near their friends in a lecture room, it was possible that students had close friendship with some of the student peers in a group. In an idea screening process this can lead to favouring close friends ideas, instead of selecting the best ones. Although group members appeared to genuinely compete since correlations between the number of selected ideas per student and selection rankings were in the same range (0.489 to 0.546, sig. 0.000). As a result, ideas had even chances to be selected any of the ranking position which could be considered as an indicator of fair competition.

4.4 Hypothesis testing and discussion

Relating to our hypothesis testing "*the greater number of generated ideas is enhancing student chances to pass his/hers ideas through subsequent interactive idea screening process when it is conducted by group of student peers*" correlation between total idea count per student and the number of their selected ideas was weak but existing (0.286, sig. 0.013). Interestingly, the idea quantity was helping only during the third best idea selection (correlation 0.281, sig. 0.015), but not in the case of best and second best idea selection. As a result we partially verified previous suggestion that the greater idea amount is leading to a higher idea quality (Paulus et al. 2011) and we can accept our hypothesis. However, it appeared that idea quantity was helping only on the later stages of idea selection (i.e. the third selection, but not the first and second selection).

From quantity vs. quality focused idea generation strategy point of view, our result is also interesting. As pointed out by Rietzschel (2005) by following Darwinian (Simonton, 1999) view of creativity, all ideas have an equal chances to be selected as the best idea or by following deep exploration view of creativity (Finke et al. 1992) grounded on higher originality and going beyond conventional ideas, in both cases quantity should lead to quality. However, derived from Johnson (1972) proposal, Rietzschel (2005) challenged traditional assumptions and suggested a contradictory strategy – generating only one or two very good ideas. Our results partially support this suggestion. If the number of selected ideas in the idea screening stage is low (i.e. selecting one or two ideas), then the number of generated ideas might not be as important as in the case of selecting three or more ideas for further development in educational brainstorming context. However, to fully verify this assumption more in-depth experimental setting and empirical evaluation is needed.

5 Conclusions

By introducing the key factors influencing brainstorm process, this study provided basic guidelines and reasoning how learning experiment relating to brainstorming should be applied and could be varied in an educational context. Following the suggestions of prior studies, a nominal group based brainstorming experiment was arranged in order to test, if idea quantity is also breeding quality. A heterogeneous group of students varying in terms of ability to generate and promote ideas were divided into fifteen mixed groups. In a fair idea screening situation, we partially verified that idea quantity was also resulting quality. This is align with the existing suggestions in literature. However, it appeared that idea quantity was helping only on the third stage of idea screening process after the first two best ranking ideas were selected.

The empirical part of our study has following limitations. We were not evaluating how the student’s previous academic performance was affecting on their idea generation and screening capabilities. Noteworthy previous academic performance includes student’s earlier degree grade and the already existing grades from the ongoing degree. Further studies should cover both these factors. Moreover, a single studying task such as brainstorming session is rarely enough for completing a full course in higher education context. Therefore, it would also be worthwhile to evaluate brainstorming session results relation to final course grade. Other possible error source in our data collection process was the lack of “the best idea” definition while using “ad hoc” selection method (Hammedi et al. 2011). There are many and sometimes contrary ways to evaluate the goodness of ideas including such as feasibility, originality, risks and economic potential (Diehl and Stroebe, 1987). Therefore, selection criteria for the idea screening phase should be controlled better by making it more explicit for students and varying the criteria.

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