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The Role of the Brief in Supporting Creative Ideation in the Design Studio: Quantitative Requirements and Visual Props

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This study identifies ways to assess and improve creativity among student designers in the design studio. We examine the influence of different kinds of stimuli and communicated requirements on idea generation in creative design outcomes. The procedure entails a controlled yet analytical approach to measure and determine whether the stimuli of quantitative data, visual and physical stimuli can potentially affect creativity. The first factor controls how much numerical/descriptive information should be provided in brief composition. The second factor controls whether visual props should be attached to the brief. The third factor controls whether physical props should be provided to the teams before the ideation sessions. The statistical analyses, along with the qualitative analysis, suggests that design briefs with quantitative data and visual props produce high scoring ideas for both appropriateness and usability, while inversely affecting novelty measures.

Keywords: design brief; quantitative requirements; visual props; creative ideation; design studio

1 Introduction

Design is an ill-defined, complex, and multifaceted problem-solving activity concerned with cognitive abilities, such as creative thinking. During the process of solving design problems, novice design students face several issues, including underdeveloped knowledge structures, and insufficient communication with their instructors (Yang et al., 2005). Another challenge is that design problems are fuzzy, and students are rarely aware of how their design solutions are evaluated. While some degree of ambiguity is desirable to promote innovation and creativity in the design studio, instructors should take care to provide the necessary conditions for minimal frustration and confusion (Sawyer, 2017). This raises the question about the kind of design brief that should be given to the students.

The design brief is a document available from the beginning of the design process, that is used by an individual or a workgroup to outline the expectations for the commissioned design task. In consultation with the 'client', the design brief articulates in a condensed form the desired results and the businesses', persons' or organizations' needs for the design. It generally conveys what is to be achieved for the client, but by no means the way to do it (Koronis et al., 2019). It is frequent that design instructors are not always conscious of insufficiently tackling this problem, and consequently, they do not facilitate appropriate resources to support students during the design problem-solving activity. Addressing this gap is highly impactful because the way that the design problem is described in the brief, together with the available stimuli supporting the design assignment, has a determinant influence on the creativity of the design outcomes.

Unclear communication of helpful sources for problem resolution can lead to misunderstandings and have a negative influence on the students' motivation to produce innovative outcomes. Therefore, a brief constructed with relevant information, paired with a supportive environment is crucial to understanding the design assignment, and developing the design solution successfully (Chen, 2016).

While considering the above dilemmas, this paper seeks to contribute to the field of creativity research, by investigating the differences between various design brief conditions. Accordingly, this study attempts to analyze how quantitative brief requirements and different types of available stimuli contributes to enhancing the creativity of design outcomes. The main goal is to explore how different conditions, in which the brief and external props such as a video and a physical representation are provided, can affect the creativity of design outcomes. Consequently, the following research questions are addressed:

RQ1: What are the props/information combination that best support creativity of the design outcomes in terms of novelty, appropriateness, and usability?

RQ2: From those conditions which are the ones more likely to show multiple significant differences in terms of each metric creative outcome?

2 Background

2.1 Measures of creativity: Novelty, Appropriateness, and Usability

The study of creativity is broad and interdisciplinary, spanning the social sciences of psychology and sociology, as well as the sciences of architecture, engineering and design. Creativity itself is composed of novel ideas; however, even the most profound ideas do not arise from nowhere. Studies which explore students' creative outcomes observed that the participants appear to be affected by stimuli; thus, suggesting that fixation emerges when participants are exposed to concept ideas (Smith et al.,1993; Howard et al., 2010; Kang et al., 2018;).

There is a consensus in the design creativity literature that creativity can be assessed using metrics of novelty and appropriateness (Amabile, 1982; Kampylis & Valtanen, 2010; Madni, 2012), and usability. The latter is a quality attribute described by Nielsen (1993) as an outcome encompassing effectiveness, efficiency, and user satisfaction in the context of use (ISO, 2013). As such, in the present study, we evaluated the creativity scores of the produced outcomes based on assessments from professionals and academic expert judges on these metrics. Three independent raters evaluated concept drawings produced by the students in line with Amabile's (1996) peer evaluation technique, utilizing a rubric-based system. The total score for each sketch was obtained as an average of the three scores. For complete evaluation rubrics and examples on grading analogous design solutions see Kang et al. (2018) and Koronis et al. (2019).

2.2 The design studio and the development of creative skills

The design studio is commonly referred to as the core of design education, where the largest number of credit hours of one's studies is dedicated (Gajda, 2016). As a teaching environment, the design studio is long viewed as paradigmatic for many other areas of education, including professional education (Waks, 2001). In this setting, students practice with real-life problems to acquire theoretical and professional knowledge, skills and techniques (Crowther 2013) and integrate them with what they have learned in different courses (Dermibas & Demirkan, 2007).

Enhancing design creativity is a central concern in the educational curriculums of design departments. How creativity can be promoted and nurtured, and under what learning conditions, is a constant challenge in a studio-based environment (Budge et al., 2013). An underlying assumption is that interaction among students working in a group enhances the flow and mutual development of ideas (Goldschmidt & Tatsa, 2005). That is why exposure to as many ideas as possible is essential to promoting and encouraging creativity in the studio.

Encouraging students to take risks and giving them the freedom to experiment in the generation of their own concepts and ideas was found to help promote creativity, even at the expense of committing mistakes (Graham & Zwin, 2010). The idea generation process can be strengthened by an educational environment in which the traditional figure of the instructor as an authority is avoided (Goldschmidt et al., 2010), and students are encouraged to work synergistically as a group (Casakin & Badke-Schaub, 2015).

Whereas several studies focus on how creativity in learning environments, such as how the studio can be stimulated, enhanced, and developed (Craaft, 2006), this study focused on how creativity can be supported (e.g., Budge et al., 2013), particularly through the crafting of design briefs to maximize creative idea generation.

2.3 The design studio and the design briefs

One of the recurring difficulties in teaching design is that the process is poorly understood. Gaining insight into the design assignment is critical to deal with a task. It is quite frequent that students experience problems of communication with their instructors or feel that they do not receive the support they require. These lapses have significant consequences on the manner in which design students approach and structure the problem at hand.

According to Brown (1989), designers tend to develop expertise in response to the requirements of the briefs they deal with. Indeed, the way that design briefs are represented and framed plays a crucial role in design problem solving in general (Paton & Dorst, 2011), and particularly in design education (Liu et al., 2018). Framing briefs and supporting them with appropriate information can help students to improve design problem-solving skills and develop creative outcomes from the early stages of the process.

There is an emerging corpus of research dealing with the effects and use of design studio briefs on the designers' outcomes. Among these studies, the need for structuring briefs to assist the learning process in the studio, in contrast to the availability of open-ended assignments to promote creativity has been a matter of debate in the design pedagogy literature (Sawyer, 2017). Whereas design problems are ill-defined, and therefore encompass a vast number of potential solutions, students commonly find difficulties and even get confused with design briefs that are open-ended (Chen, 2016). This phenomenon explains why some students feel secure when more constraints are added to the brief

(James, 1996). Osmond and Tovey (2015) showed that while struggling to be creative, students reported a feeling of ‘being stuck’ when exposed to unstructured briefs. However, these researchers also found that those students who managed to deal with the challenges of an open-ended assignment were able to increase their creative confidence and defend their ideas. In another study, Oliveira and Marco (2017) showed that the absence of a prescribed brief allowed students to focus on different aspects of the design from a personal and broader perspective. However, framing briefs based on individual ambition led to too many different interpretations of the design problem. This was in detriment of fully engaging and developing the design solution in line with the initial requirements.

Some researchers suggested balancing open-ended with more structured approaches. Lee (2009), for example, proposed to deliver projects differing in their level of freedom, from structured to highly structured. Rutherford and Wilson (2006) suggested that open-ended briefs should be encouraged, but also reviewed to ensure that the design studio aims, and objectives are preserved. On the other hand, there also appears to be some consensus that less prescriptive and more flexible design studio briefs can encourage personal reflection, creative thinking, and may contribute to support more individuality in the projects (Pan et al., 2012; Rutherford & Wilson, 2006).

The manner in which a brief is framed has important consequences on the way in which a task is approached, what aspects of the design are stressed, and what kind of creative outcomes are produced. The factorial studies of Kang et. al (2018) and Koronis et. al (2019) demonstrated that including conditions such as visual and physical props during the presentation of the design brief decreases the novelty of the produced concepts. Therefore, it seems that giving less specific requirements without examples appears to be more effective for the generation of novel ideas (Koronis et al., 2018). On the other hand, it is essential to provide students with good examples of successful products together with detailed specifications to ensure that their concepts will be aligned with the brief guidelines (Kang et al., 2018). In this study, we will explore the extent to which using different brief conditions supports creative ideation in design problem-solving. The design outcomes are measured with Amabile’s (1996) Consensual Assessment Technique, measuring novelty, appropriateness and usability.

3 Research Method

3.1 Participants

The sample consisted of 171 student designers between the ages of 18 and 25 (mean age = 20 years old), 65% of which were male and 35% female. Participants were recruited in a first-year undergraduate design class, and students who participated had yet to select their major. All students were randomly assigned to the control and the other 7 conditions. They were informed that their participation would have no impact on their academic grades, as it has been argued that students tend to be less creative in class projects when there is a risk of receiving poor grades (Linnerud & Mocko, 2013). Although this experiment design studios had different instructors, they followed the same curriculum and progressed at the same pace. Therefore, we assume that the combination of students in the design studio groups are reasonably homogeneous, thus allowing for a fair comparison between the different conditions.

3.2 Design Task

All participants were provided with the same design problem, which consisted of designing "A device to extract juice from fresh oranges at home" and were tasked with sketching solution concepts. The same design problem was delivered to subjects in previous work on idea generation sessions carried out by Koronis et al. (2018). As in that study, they were told to avoid using blenders or blender-type machines as a reference for their concept designs. Orange juice extraction devices were chosen for the design problem as they are relatively common and reasonably familiar devices, which most students have used or encountered before.

3.3 Procedure

The experiment was run in a total of 8 design studios consisting of 20-24 students each. Students were grouped in mixed-gender groups of 4-6 participants. Each design studio was given the baseline design brief with different combinations of supplementary information in the form of visual or physical props or quantitative information along.

Based on the design brief given to each design studio, each workgroup completed a combination of Collaborative Sketching (C-Sketch) / 6-3-5 exercises. We consider it a combination as the groups were not consistently composed of 5 students as would be required by the 6-3-5 methodology. Moreover, writing of notes, and minimal talking was allowed among the teams. The design brief was displayed on projectors in the classrooms for around 2 minutes before the commencement of the C-Sketch / 6-3-5 exercise. Thereafter, it was projected again during the design activity as a reference for the students throughout the duration of the exercise (≈1hr). There was no group discussion session after the screening of the design brief and thus students were expected to respond according to their interpretations.

Each team member spent the first 15 minutes sketching three different ideas. Subsequently, at 10-minute intervals, each student passed on the sheet to a group peer, so that he or she could add sketches and annotations to the ideas of previous team members. This rotation process was repeated until each student got his/her original sheet back. Students received no prior training on this set apart from the instructions provided in this experiment. In total, 506 concept sketches were generated in this exercise. After students' drawings were completed, they were submitted back to expert assessors for their assessment.

3.4 Conditions and evaluation of sketches

This study investigates three information types paired with design briefs including: i) quantitative requirements; meaning information on specific costs, maximum number of manufacturing processes, durability cycles and product volumes; ii) a visual example, represented by a video showing a person using a conventional orange squeezer, and iii) a physical example, which consisted of a single-part orange squeezer sample that is handed over to selected design studio groups. Table 1 shows the mean scores and standard deviations (Std) for each response. Under the column titled "Condition," a "+" indicates the presence of that variable, while a "-" indicates its absence. In this arrangement all possible combinations of the three different types of stimuli, yielding 8 different conditions, are analyzed. Mean scores for novelty, appropriateness, and usability, with the standard deviation bars for each brief, are displayed in Figure 1.

This resulted in each sketch having a score for novelty, defined as the extent to which the design is different from the usual way of extracting juice; a score for appropriateness, defined as the extent to which the design is aligned with guidelines of the design brief; and a score for usability, seen as the ability of the design to extract the most amount of juice with minimal effort efficiently. The analytical rubric score ranges can be found in the earlier works of Koronis et al. (2018) and Koronis et al., (2019).

Table 1. Descriptive Statistics for the Three Creativity Metrics, by Brief Setting

Brief	Condition	No. of Student	No. of Sketches	Novelty Mean		Novelty Std	Appropriateness Mean		Appropriateness Std	Usability Mean		Usability Std
A	Q-V-P-	26	76	3.01	±	0.77	2.57	±	0.79	2.61	±	0.52
B	Q-V-P+	24	70	2.71	±	0.65	2.63	±	0.71	2.63	±	0.64
C	Q-V+P+	21	60	2.68	±	0.65	3.08	±	0.54	2.83	±	0.66
D	Q-V+P-	20	63	2.84	±	0.81	2.75	±	0.72	2.89	±	0.58
E	Q+V-P-	23	68	2.99	±	0.86	2.79	±	0.86	2.65	±	0.78
F	Q+V-P+	14	40	2.47	±	0.82	2.58	±	0.71	2.78	±	0.61
G	Q+V+P+	20	60	2.52	±	0.74	2.96	±	0.78	2.69	±	0.51
H	Q+V+P-	23	69	2.49	±	0.75	3.14	±	0.66	3.02	±	0.51
Totals		171	506	2.71		0.76	2.81		0.72	2.76		0.60

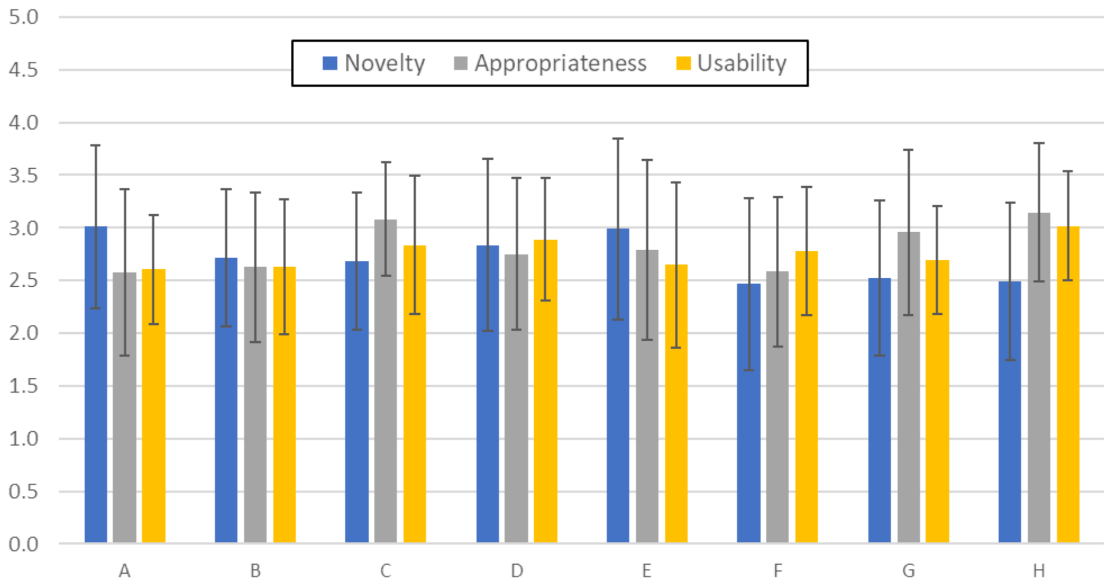

Figure 1. Bar chart of the three responses values per brief

4 Results

In the first part of this section, we carried out a quantitative analysis to explore whether significant differences emerged between the varying conditions, as presented in Table 1. The pairwise comparisons between the different briefs determined whether likely ranges for the differences can be found. In order to gain further insight, in the second part we selected and analyzed conditions with the higher and lower averages for each of the creativity variables assessed by novelty, appropriateness, and usability. We illustrated successful and unsuccessful examples of the solutions produced by the different teams in the Collaborative Sketching (C-Sketch)/6-3-5 exercise.

4.1 Quantitative analysis

A one-way between-groups analysis of variance was conducted to explore the relationship between the varying conditions. Subjects were divided into eight groups according to the different conditions they were exposed to. A Kruskal–Wallis Test revealed a statistically significant difference was found across the eight conditions followed by pairwise comparisons which indeed pointed out in-between difference across briefs. In this work, the statistical analysis was run on sketch-level (N = 506) where each sketch is treated as a unique observation.

4.1.1 ANOVA Testing Assumptions

The Levene's Test for Equality of Variances showed a departure from homogeneity (p>0.05) and the assumption of homoscedasticity was violated for Appropriateness and Usability but was found acceptable for Novelty. The data were non-normally distributed for the dependent variables according to the Shapiro–Wilk's test of normality and Levene's test for equality of variances shows that the assumption of equal variance was not met for all variables. As such, a Kruskal–Wallis, the non-parametric equivalent to the standard ANOVA test was employed. All the above indicating a non-normal distribution and inferring the use of non-parametric measures for analyses such as the Kruskal–Wallis ANOVA.

4.1.2 Inter-Rater Reliability

At the cessation of the creativity evaluation, the interrater reliability was checked for consistency between judges. The degree of agreement between judges is reported under the intra-class correlation coefficient (ICC-1) estimates in Table 2 based on a two-way random effect, average measures model. To check inter-rater reliability, IBM SPSS version 25 was used to calculate the intra-class correlation coefficient (ICC-1) Based on the 95% confidence interval of the ICC estimates, all reliability values were in the good to fair range, for novelty (ICC=.642), appropriateness (ICC=.649) and usability (ICC=.483).

Table 2. Interrater Reliability Results and ANOVA Assumption Testing

Distributional Label	Intraclass Correlation[a]	Normality test, Shapiro-Wilk	Homoscedasticity, Levene's test
Novelty	.642[b]	nonnormal	homogeneous
Appropriateness	*.649*[b]	nonnormal	non-homogeneous
Usability	*.483*[b]	nonnormal	non-homogeneous

a. Type A intraclass correlation coefficients using an absolute agreement definition.
b. This estimate is computed assuming the interaction effect is absent

4.1.3 Novelty statistics

The Kruskal-Wallis Test revealed a strong statistically significant difference ($p<0.001$) in novelty scores across six different conditions in the mean ranks of at least one pair of groups (χ^2 (7, n=506) = 33.22, p=0.00). There was very strong evidence ($p < 0.003$, adjusted using the Bonferroni correction) of a difference between the briefs A-G (p=0.012), A-F (p=0.011), A-H(p=0.003), G-E (p=0.019), E-F (p=0.017) and E-H(p=0.005). There was no evidence of a difference between the other brief pairs.

4.1.4 Appropriateness statistics

Further, the Kruskal-Wallis Test reported a statistically significant difference across six different conditions in appropriateness scores (χ^2 (7, n=506) = 37.27, p=0.000). A difference between the briefs was observed in the pairwise comparisons for F-C(p=0.015), F-H(p=0.009), A-C(p=0.003), A-H(p=0.003), B-C(p=0.007) and B-H (p=0.003). There was no evidence of a difference between the other brief pairs.

4.1.5 Usability statistics

A Kruskal-Wallis Test revealed strong evidence of difference across four different conditions in Usability scores (χ^2 (7, n=506) = 29.48, p=0.000). A difference between the briefs was observed in the pairwise comparisons A-H(p=0.001), B-H (p=0.001), E-H(p=0.012) and G-H(p=0.047). There was no evidence of a difference between the other brief pairs.

4.2 Qualitative Analysis

4.2.1 Novelty and the generation of creative design solutions

In the condition where most design solutions rated as highly novel, only the baseline brief was provided to students. Figure 2 illustrates an example of a highly novel solution to the orange squeezer problem by one of the teams that participated in this condition. The solution, which was considered to some extent surprising since it succeeded in modifying existing paradigms, created a sophisticated machine characterized by an isolated electric moving system fed by batteries. The juice is extracted because of the rotation of a mounted disc around the orange. The mechanism is enabled to hold the orange in place within an internal cabin, but at the same time extracts the juice via rotation out through an external pipe. The system is waterproof designed, and sports a screen door fastened by four magnets from which the user can observe the whole juicing process. It is remarkable that although no additional aids or props were provided to the design team, the produced solution scored a 5 for novelty, the highest possible score for the Likert-based metric. A plausible reason for this could be that the basic brief was informative enough to let the students know about the design needs and gave wing to their imagination, without constraining or fixating them to example solutions.

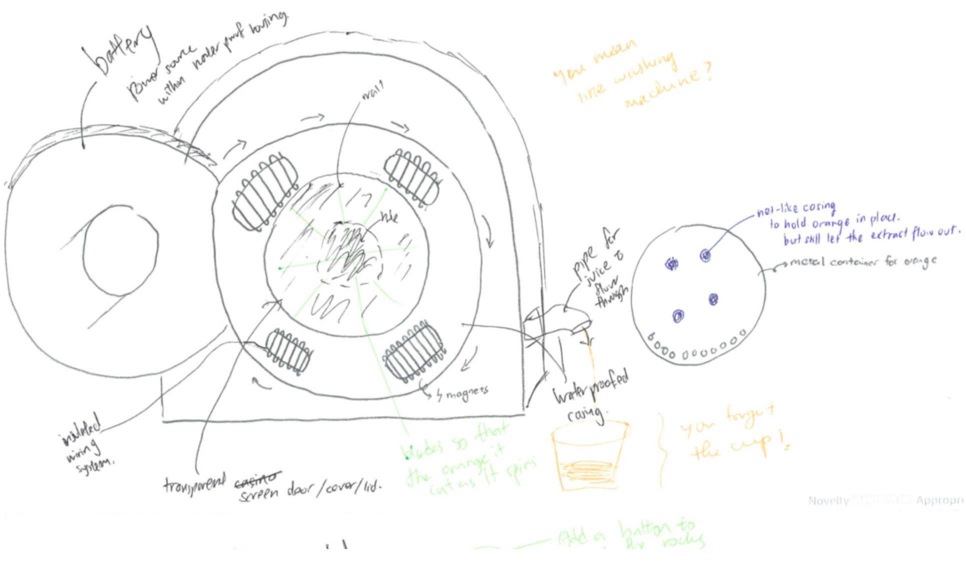

Figure 2. Sketch from Brief A (control) that scored high in novelty

The condition where most solutions scored lowly on novelty was that in which the control brief in addition to quantitative information about the problem and a physical model was provided to the participants, also known as Brief F. In Figure 3 an example of a solution for this condition can be found. Remarkably, the design outcome was almost a copy of the standard prototype for the manual orange squeezer in the market. Probably, the standard prototype is common knowledge to most designers, and combined with the stimuli provided and the quantitative requirements and constraining information may have caused the participants of this group some level of fixation thus affecting the novelty of their design solution. Only slight modifications were observed, such as the addition of a filter added to the base of the squeezer not found in the visual props. As a result, this solution scored only 1.00 point for novelty.

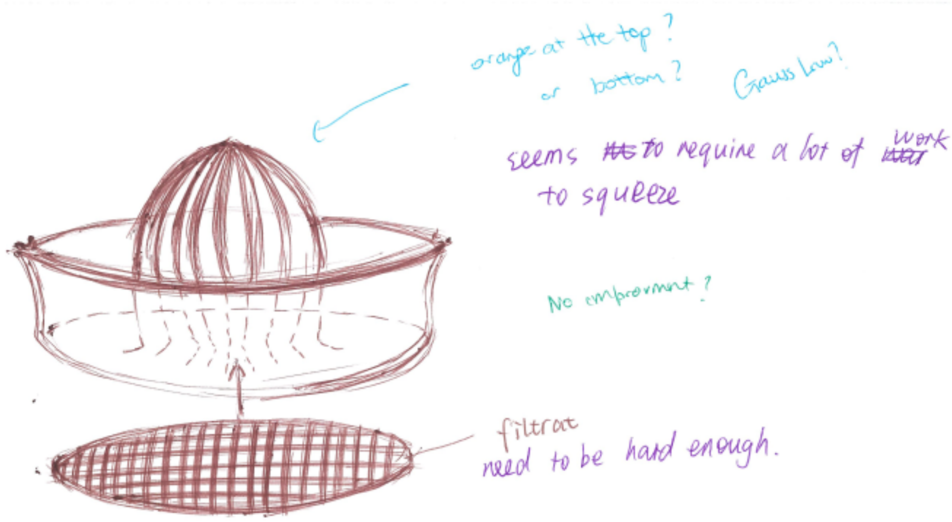

Figure 3. Sketch from Brief F with low novelty score

4.2.2 Appropriateness and the generation of design solutions

The condition where the most solutions scored highly for appropriateness was that of Brief H, where students were exposed to the baseline brief accompanied by quantitative information and a video example. Figure 4 shows an example of a representative solution for this condition, which was considered to respond satisfactorily to all the needs and requests from the brief (e.g., easy to manufacture, washable, low cost, etc.). It is possible that the supplementary quantitative information, which served to gain more insight into the design requirements, helped students pay particular attention to the initial needs of the baseline brief. On the other hand, the video example probably aided to figure out tangibly how such requirements can be materialized in practice. The solution was seen as very appropriate and in line to the brief requests and thus scored 4.67.

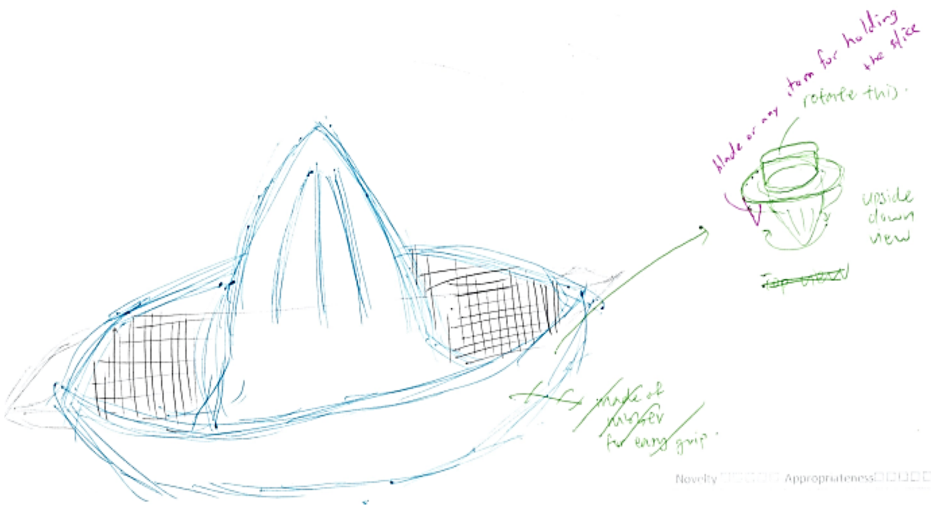

Figure 4. Sketch from Brief A (control) that scored high in appropriateness

In the condition where most solutions scored lowly in appropriateness, the control brief without any example was provided to the students, namely Brief A. Figure 5 illustrates an example of a solution for this condition that did not address the design requests. It can be observed that the device is characterized by a complex mechanism composed of many parts, which makes it difficult to manufacture and clean, and that largely exceeds the target cost. It seems reasonable to consider that the lack of external aids such as quantitative requirements with specific numerical values, or a visual example were the main causes for these low scores observed. It is remarkable that whereas the final solution only scored 2.57 for appropriateness, it was rated highly for novelty. As demonstrated earlier, the lack of external props seemed to contribute to the production of unique solutions.

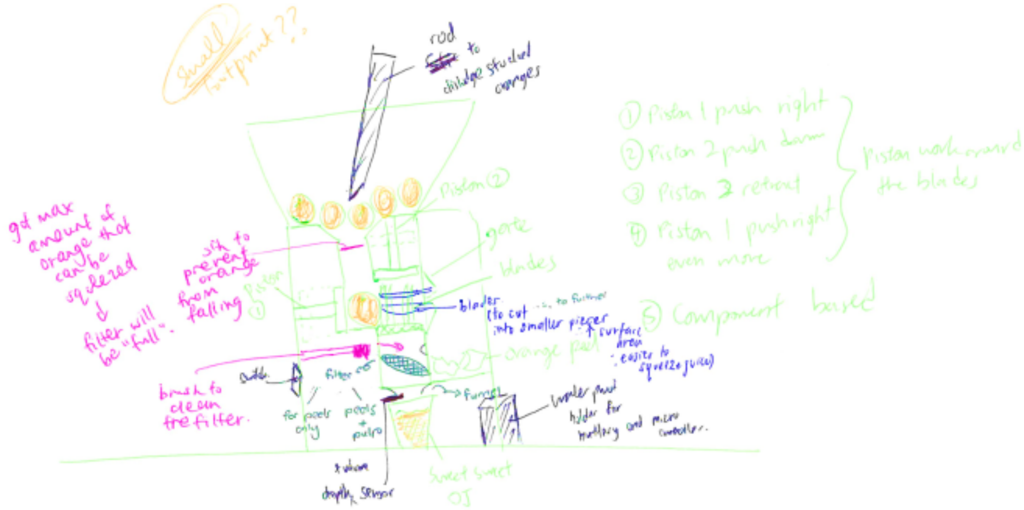

Figure 5. Sketch from Brief A that scored low in appropriateness

4.2.3 Usability and the generation of design solutions

In the condition where most solutions scored highly for usability, participants were provided with the baseline brief accompanied by quantitative information and a video of a typical orange squeezer, namely Brief H. An example of an idea solution produced in this condition can be seen in Figure 6. The solution, consisted of a practical device composed of a handle with an ergonomic grip used to press the fruit, a removable squeezer element, a rotatable plate, and a cup to store the juice fixed to a heavy base, which was intended to increase the stability of the device. It is remarkable that the same condition was beneficial to produce not only the most usable solutions but also the most appropriate ones. It is likely that the available quantitative information helped students to produce a very efficient design outcome that did not violate initial design constraints, which combined with an instructional video prop served to gain a better understanding of the devices' function and how it can be easily implemented and materialized in practice. The solution was regarded as very useful and scored 4.00.

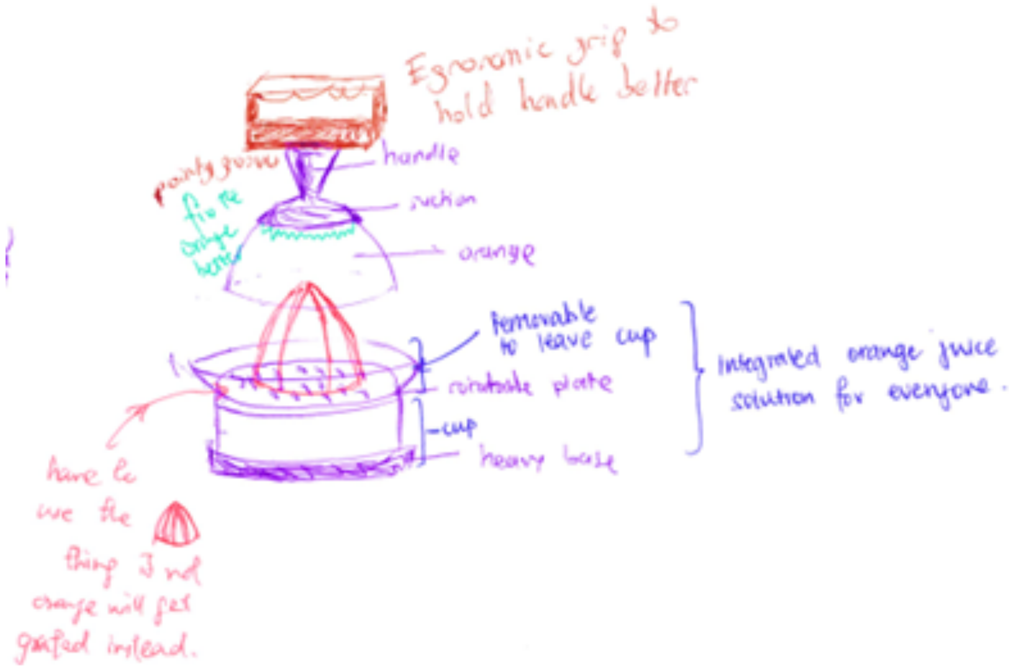

Figure 6. Sketch from Brief H that scored high in Usability

When students were exposed to the baseline brief and a physical model as a possible solution example, namely Brief B, most design outcomes scored lowly for usability. Figure 7 depicts an example of an idea-solution for this condition that did not manage to satisfy functional needs. The solution consisted of a detachable sharpened straw, which could be inserted directly into the fruit. The lower part of the straw has a rough surface that when turned around breaks the skin of the orange. The idea was that the device would allow users to drink juice directly from the orange. However, the idea was considered impractical and scored 1 for usability. With the absence of quantitative information, it seems that the physical model alone was not effective to exemplify how the device could be implemented in real life.

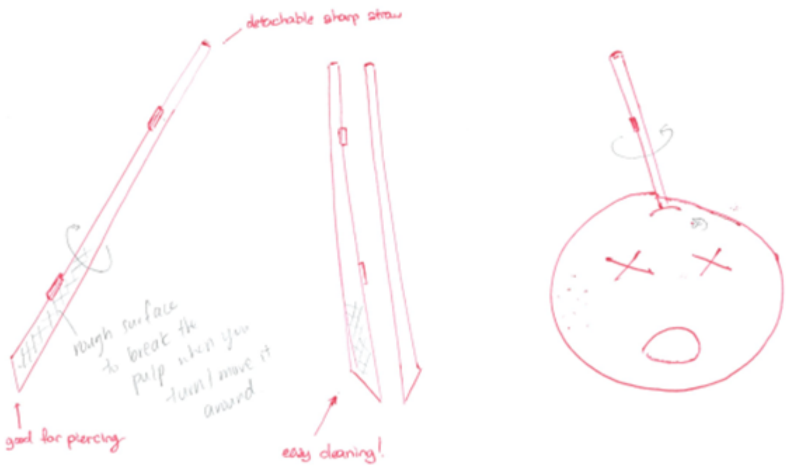

Figure 7.Sketch from Brief B that scored low in Usability

5 Discussion and conclusions

The Kruskal-Wallis ANOVA results showed that there are significant differences in the design outcomes between design studio groups that received briefs with different sets of stimuli. Surprisingly, the simultaneous statistical tests revealed that the inclusion of visual and physical props in the design brief decreased the novelty scores of the ideas developed by the students. Hence, for novelty, the control condition (Brief A) was found to have significant differences with the other conditions. These findings are consistent with prior studies which showed that participants who are exposed to examples of existing products tend to produce fewer novel examples because of the design fixation effects (Jansson & Smith, 1991). An earlier factorial study on the same design problem as this study indicated design fixation as one of the factors for a lack of novelty (Kang et al., 2018).

Regarding the appropriateness and usability creativity metrics, the pairwise comparisons indicated that Brief H, in which a video example was given in addition to the baseline brief, had multiple significant differences compared to the other conditions. If the primary aim is to increase performance and user-friendliness, it can be argued that providing a visual/video example is beneficial for usability. This claim can be supported by Fu et al. (2010), who claimed that good examples can help design teams to generate high-quality ideas that fulfill the brief's requirements. Accordingly, students can build on solutions that are known to be effective.

Implications for design education can be concluded from the present findings. Educational programs aimed at promoting design creativity in engineering and architecture studios may find it useful to consider the way that design briefs are structured, and support from instructors can either encourage or deter different aspects of design creativity. Whether using examples or not as a pedagogical tool to enhance design creativity, and the type of examples used showed to be largely dependent on the aspect of creativity that is intended to be promoted. In this sense, a remarkable finding was that no brief was helpful enough to enhance all creativity metrics simultaneously. On the other hand, briefs that supported design novelty, failed to yield high appropriateness and usability scores, and vice versa.

One limitation of the present study is that it was carried out in a classroom environment that only addressed the ideation phase of the early design process. Therefore, in spite that the present findings provide insights into the advantages and disadvantages of considering the different conditions in the design studio, they should be taken with some caution. It is possible that when considering the overall design process along a whole semester, students would become more familiar with the use of the different briefs. Consequently, the influence of the type of brief on the creativity of the design outcomes might differ to some extent compared to the present findings. Irrespectively of this, it seems that training student designers in using briefs with different types of information can be seen as an important part of the educational scaffold of the studio aimed at enriching the learning experience of the student.

Another limitation of this study is the relatively small sample size and the fact that employing university students as participants may be imperfect if studio managers consider applying the key findings to senior and professional populations. Future research in this area should consider extending this study with professionals from the engineering, design, and architecture domains to validate the findings of this paper.

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