Quantifying Product Creativity in Design: A Quasi-Experimental Methodological Approach

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Abstract
Creativity research studies have been predominately focused on adopting methodologies rooted in psychology. Employing various psychometric approaches, experts use sophisticated statistical tools to understand the multifaceted aspects of creativity (Long, 2004). Quantitative methodologies dominate the field of research, specifically creativity metrics which seem to be contingent on psychometric enquirers that primarily test creative thinking. Experts now imply that disagreement on some of the key issues of creativity assessment and measurement could indicate a lack of methodological diversity (Hove 2004). As such, this study proposes an adapted quasi-experimental approach. A game-like task (CBoard©) was developed in order to generate products in an attempt to quantify a creativity dimension: flexibility. The step-by-step model proposed here is a methodological approach that could be applied to the study of creativity in domains that exist outside psychology.

Keywords
creativity, creativity measurement, quantifying creativity, creativity methodology, quasi-experiments in creativity, creativity in design, creativity in higher education

1. Introduction
This paper aims to propose a methodological model that allows the study of creativity measurement outside psychology. The model will be exemplified by directly referencing aspects of a broader research study that is centred on quantifying creative manifestations in design. In an attempt to identify some of the challenges when approaching the topic as a non-psychologist researcher, the paper will initially outline some of the most common research approaches when studying creativity. Subsequent sections of the paper will address the linear development of the model by breaking it down into six steps.

2. Methodological approaches and challenges when studying creativity
Creativity, a philosophical annoyance riddled with paradoxes that often leave researchers in a frustrated position, is a topic of investigation that is as fascinating as it is challenging. Scholars argue that in today’s society, technologies are quickly transforming information into accessible commodities and attention should be shifted back to the individual, who has the unique capacity to create (Corazza 2016). Experts warn that with the continuous growth and development of these technologies, the social and
economic ecosystem will change. Hennesey and Watson (2015) support this argument, reinforcing the idea that understanding creativity in humans should not be neglected nor delayed. The sense of urgency that seems to dominate recent published studies point towards the necessity to take action. As a distinctive feature of humanity (Sternberg 2018) the creativity puzzle and its practical importance are both driving and feeding research curiosity. The topic means different things to different people, and its challenging nature causes consequences that in research terms make its investigation problematic.

Sitting under the umbrella of an established subject like intelligence, creativity is yet to ascertain itself as a robust field that can yield unanimously accepted social contributions. Despite 70 years of research, creativity remains a fuzzy concept which is known to invite controversy, and often leads to theoretical disagreements (Sternberg 2018) that ultimately prevent the field converging. The polemic nature of some of the key questions that range from what is creativity to how can it be measured puts researchers in a vulnerable position. Often exploratory, creativity investigations have been criticised for their lack of methodological diversity and occasionally rigour (Long 2014). The number of disagreements that riddle creativity as a field, have left researchers to conclude bitterly that creativity is somewhat of a scientific disaster area (Kharkurin 2014, directly quoting Kaufmann 2008).

Yet, creativity as a research topic warrants further analysis. Despite these challenges, the field is not short on contributions. Findings are continuously being published and the body of literature has been growing substantially. A review conducted by Long (2014), found that about 1,127 studies were published between 2003 and 2013 in five top creativity journals. A vast majority of these were quantitative in nature and employed one of the following six methodological approaches: psychometric, experimental, biographical, contextual, biological or computational1 (Wehner, Csikszentmihalyi and Magyari-Beck 1991; Long 2014). As creativity is embedded in intelligence research, a good proportion of these papers (62%) belong to psychologists, who follow a psychometric research approach (Long 2014). The mental capabilities of the individual are at the forefront of this approach and the research question is often centred on the question of how could these capabilities be measured? The familiarity of the psychometric approach together with the well-defined parameters of studying it from a psychological perspective tacitly suggest that perhaps this is the best way

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1 Psychometric: researchers consider creativity a mental trait and administer questionnaires. Biographical: researchers use existing biographical data to identify creativity via case studies. Experimental: researchers view creativity a cognitive process use problem solving experiments. Biological: researchers try to understand creativity by neurologically monitoring brain activities. Computational: researchers view creativity as a process that could be mimicked by computers. Contextual: researchers view creativity as a result environmental influences.
forward, at least from a methodological perspective. Despite the merits of the psychometric approach, Mumford (2003) points out that this might be an indication of methodological isolation. The application of one methodological approach to the exclusion of others could have drawbacks on the integration and application of findings. "While the psychometric approach to intelligence is generally considered one of psychology’s greatest success, the same cannot be said about the cumulative approach to the study of creativity...particularly once one transcends the ‘cocktail party’ variety of creative production” (Policastro and Gardner 1999: 213). Reiter-Palmon et al (1997) also advocated a multi-method perspective, which they believed could lead to more comprehensive research designs. As Mumford (2003) notes, non-psychometric research approaches come with limitations that researchers must be prepared to acknowledge. These are relatively new approaches that have not been tried, tested and refined, therefore caution must be exercised when discussing findings. However, the consensus is that creativity would benefit from being studied through other disciplinary perspectives (Csikszentmihalyi 1988). Allowing a more flexible, multi-disciplinary study of creativity, non-psychologist researchers could venture towards one of the other five approaches (Long 2014). Some studies, which range from life story investigations (Hass 2012) to breaking down what makes a digital game creative (Chuang and Huang 2015), show that researchers attempt to investigate creativity outside the psychometric approach. However, the distribution of studies shows a dispersed reality in which research projects that do not employ a psychometric approach make up only 38% of the existing body of literature (Long 2014). Despite the implication that the later studies are methodologically diverse, and researchers can mix and match the methods within the five approaches, rigour is still questioned (Rodgers and Yee 2018). These studies are driven by the same research questions of what is creativity and how can it be measured, but mixing methods has left non-psychologists susceptible to criticism (Rodgers and Yee 2018). The aftermath of research accessibility opened up the discussion on the methodological relevance of non-psychometric approaches. It could then be tentatively speculated that methodological flexibility seems to cost research accuracy. The need for a similarly sound approach as psychometrics that would allow the study of creativity outside the psychological domain could be perhaps of value. Hence this paper is proposing a research methodological procedure that hopes to show that there could be ways to study creativity in other domains without inevitably implying methodological weakness. As mentioned above, the proposed approach is part of a larger research study that aims to quantify product creativity in a domain that does not traditionally sit under the psychological umbrella, namely design.
3. Methodological procedures that allow the exploration of creativity measurement

When the question that drives a research project is how to quantify product creativity, one of the first decisions centres on optimum ways to explore it. Although a seemingly straightforward process, the very nature of creativity and the state of play in the field make the issue of methodological selection challenging. If the rule of the many trumps the rule of the few, then the psychometric research approach is favoured. However, if the research question is framed in a field that is conceptually distant from psychology, as it is in the case of design, the choices are anything but clear-cut. The decision is inherently complex, as a selection must be made between possibly compromising research rigour or becoming a psychometric specialist. Feasibility wise, the latter is not an option, therefore the sensible way forward would be to pick one of the five approaches and adapt it in a manner that would still follow the perceived rigour of the psychometric principles.

Out of the five approaches, historically, experimental research procedures are closely linked to the field of psychology (Harris 1986) and are viewed as being methodologically stronger. This was one of the first avenues considered fit to adapt when conducting a research project that sought to look into creativity from a design perspective.

When investigating creativity, experimental researchers place the manifestations of creativity at the centre of their study. These manifestations are considered to be creative products in the broadest sense, ranging from ideas to tangible outcomes. Experimentalists view creativity as a cognitive process than could be studied through these manifestations (Long 2014). By reframing the ‘object’ of investigation from the mental capabilities of the individual and placing attention onto the manifestations of these mental capabilities, the study of creativity can be approached from a multidisciplinary perspective. The assumption therefore is that if these products are measured, the mental processes are also implicitly measured. Pure isolation and distinction of the two is not necessarily possible. As such, an element of psychometrics will always be present when taking this approach. The experimental methodological procedure calls for experiments (as methods of choice) that have been historically designed by scientists and social scientists. Credibility is under scrutiny when a non-psychologist/non-scientist researcher presents findings following this approach (Rodgers and Yee 2018). A clear step-by-step methodological model is not yet available to researchers, which places the study of creativity outside psychology. In a quest for methodological rigour, this paper will therefore suggest a model that will mainly employ an experimentalist approach with some elements of psychometrics. The methodological approach proposed here will be referred
to as a quasi-experimental approach\textsuperscript{2}. These types of experimental approaches are slightly more flexible and allow the study of topic from a multidisciplinary point of view.

\textbf{4. A proposed methodological approach}

Traditionally, research in creativity seems to be quantitative in nature, however an argument can be made for a mixed approach. Fryer (2012) points out that employing qualitative methods could offset the weaknesses of the quantitative approaches. While non-psychologist researchers express a clear preference towards qualitative methods, they also mix methods to manage the idiosyncratic nature of the data they collect. As methodological rigour is a particular source of concern, mixing methodologies and methods could be often seen as a strategic decision that minimises error. The methodological approach proposed here seeks to balance qualitative and quantitative procedures for what is hoped to yield valid results in the study of creativity in design. The following sections will outline the step-by-step model.

\textbf{4.1. A six-step model}

The quasi-experimental model proposed here (please refer to figure 1) will be broken down into six steps initially addressing the theoretical underpinnings that lead to the creation of each step.

\textsuperscript{2} Quasi Experimental Designs: the researcher does not have complete control over the cause and effect relationship between the two variables (Field and Hole 2003).
Figure 1. A quasi-experimental approach for the study of creativity in design. A six-step model (Author’s own 2018)
Step 1 | Converting the research question into a hypothesis

In the exploration of issues at the heart of the question *how could product creativity be measured*, much rests on how open or closed the question is (Denscombe 2002). As a subject that prompts controversy, identical research questions can yield manifold results that can be interpreted in a multitude of ways. To make the task more manageable, the question is often broken down into twofold research paths:

- product generation and consequently measurement or;
- existing product compilation and then measurement.

Probably the most famous example of the former is in Guilford (1983), in which participants were asked to generate ideas for unusual uses for a paper clip. These ideas were subsequently judged and scored. Similarly, various examples of the latter can be found in the literature, where either everyday products such as chairs ³ (Besemer and O’Quinn 1999) or socio-culturally creatively accepted products, for example Shakespeare’s sonnets (Simonton 2012) were collected and then scrutinised by their creative strengths and weaknesses.⁴ As both lines of research are open to controversy, methodological soundness calls for a narrowed research scope. One such practice is the translation of the research question into an arguably more manageable and more focused hypothesis (Harris 1986). In addition, hypotheses are usually aligned with the experimental approach (Harris 1986).

In the context of the wider research study discussed here, product generation and then measurement was selected as the research path. This implied that in order to carry out measurement, a product needed be generated. This is arguably one of the most controversial aspects of creativity research. Being able to justify why and how the products have been generated before even contemplating quantification is methodologically challenging. The relationship between product generation and measurement becomes a hypothetical avenue that could be used to narrow down the research question. This can be done by translating the question from *How could newly generated products be measured in the context of creativity* to a hypothesis that implies conditions that would focus down the research scope *If a product is newly generated under certain conditions, then the measurement of particular aspects of creativity will be possible*. Taking into account a relationship, the research question becomes an experimental hypothesis (Field and Hole 2003).

The hypothesis implies that particular attention should be placed onto the conditions that generate said product, inferring concomitantly that not all

³ Besemer and O’Quinn (1999) used chairs as an everyday object, a commonplace invention that makes the interaction with people familiar and comfortable, therefore easier to judge.
aspects of the product will be measured. By doing this, the investigation of a fuzzy concept such as creativity could become arguably more manageable. To understand the wider context of the research study used here, key literature findings will be mentioned.

The body of knowledge on product generation is limited; however the nature of the activity that leads to the generation of these products is central to the discussion (Krumm et al 2014). In Guilford’s (1983) unusual uses for a paperclip activity, for example, any response was and still is accepted. These in turn get scored and then consequently measured against each other. One of the greatest advantages of an unrestricted, general and open task/activity is accessibility. Participants, regardless of age, background or culture could generate these products (in this case ideational responses). Accessibility, however, also means that the number of products made available could be infinite. From a methodological point of view, the absence of a cut-off point could lead to difficult or unmanageable data. As such, controlling and restricting the task/activity could possibly lead to less controversial results. Relating this back to the first section of the hypothesis, If a product is newly generated following certain conditions, then one of these conditions could be related to the nature of the task/activity.

The second part of the hypothesis the measurement of a particular aspect of creativity is comparatively more broadly covered in creativity literature (Snyder et. al 2004). A vast majority of authors discuss a number of key aspects that could be investigated when addressing product measurement:

- fluency (counting the number or products generated),
- flexibility (placing the products in different categories and scoring them on conceptual distance),
- originality (scoring on statistical infrequency)
- and elaboration (scoring how detailed the response is) (Snyder et. al 2004).

While the four creativity measurement dimensions are the cause of many disagreements in the field, fluency and flexibility seem to be two of the most accepted creativity aspects that could possibly be quantified (Krumm et al 2014). In the context of the broader study, flexibility was the dimension that was further explored. Taking this assumption into account, the translation of the research question into a hypothesis was formulated as follows: If a product is newly generated by controlling the nature of the activity, then the measurement of flexibility as a dimension of creativity will be possible.

Once the experimental hypothesis has been clarified and decided upon, the research protocol call for setting up two types of variables: dependent and
independent (Harris 1986). Directly linked to the hypothesis, the dependant variable, is the part of the hypothesis that should allow measurement (in this case flexibility) while the independent variable implies control (in this case the nature of task/activity that allows the generation of products). The following step will address the creation of the task/activity that considers the previously mentioned hypothesis: If a product is newly generated by controlling the nature of the activity (independent variable), then the measurement of flexibility (dependent variable) as a dimension of creativity will be possible.

Step 2 | Designing the experiment based on the experimental hypothesis

The second step in the methodological model proposed here implies a careful consideration of the two variables:

- The nature of the task/activity: meaning that the task or activity should allow the generation of new products in a form of control.
- The task/activity will have to allow flexibility to manifest itself, otherwise the dependant variable cannot be measured.

Design was the chosen domain of study for the investigation of product creativity measurement, meaning that the activity sought to reflect to some extent the nature of the domain and not become too general. This implied that the nature of the task will have to be specific to the domain of study. To contextualise this, a broad overview of design will be provided in the next section.

2a Developing a task/activity that is domain specific

Ranging from graphic design to architecture or fashion, design is a discipline that employs a visual, purposeful expression of a solution (Wong 1993). Designers use conceptual, visual and relational principles and elements to solve specific problems. Regardless of their discipline, principles and elements like shape, size, colour and space unify designers’ practice (Zelanski and Fisher 1996). Therefore, the activity sought to allow the application and manipulation of these domain unifying principles and elements. It was also considered that while the domain principles and elements should control the nature of the task/activity, it should also be open enough to allow the manifestation of flexibility (which in turn would imply creativity measurement). The task proposed for the study was a simple analogue game like activity: The Creativity Board (CBoard®) that asked participants to generate a creative composition in a given space, using predefined shapes. In order to align this with the conditions identified above, the following aspects had to be controlled: number and type of shapes as well as predefined space and time. The shapes, created from foam board were magnetised so they could fit on a 40x40cm white board. They included:
• 16 basic shapes (10x10cm) (two types: eight quarter of a circle and eight squares; of two different colours, black and blue).
• A predefined space 40x40cm whiteboard.
• A brief: generate a creative composition.
• Rules: stacking the shapes is not allowed and all shapes have to be used.

The manipulation of the shapes was sought to allow the application of some of the elements and principles that unite design disciplines under the domain umbrella. The task was open enough for flexibility to manifest itself, as the CBoard© allowed for the modification and manipulation of the shapes. The number of shapes and the pre-defined space, meant that the task was open enough to permit the generation of new products, while controlling the conditions under which these were created (please refer to figure below).

![Diagram of CBoard© Activity/Task](image)

Figure 2. CBoard© Activity/Task (Author’s own, 2018)

Once the activity had been decided upon and the dependent and independent variables considered and aligned with the hypothesis, the next step is to set up clear experiment protocols. These will be addressed in the next section. It is essential that step two is a direct reflection of step one and that both hypothesis variables have been considered when creating the task.

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5 Creating a task that is discipline specific and not domain specific would have placed too many restrictions and both openness and flexibility would have been under scrutiny. A domain specific task also sits somewhere in the middle between general and specific. It is not too general that it is applicable across all domains but not as specific as a discipline becoming too restrictive.
Step 3 | Setting experiment protocols

Setting up the right amount of time for any type of experimental task/activity is imperative as this could skew the results of the research study (Field and Hole 2003). After pilot testing the CBoard© proposed in step two, the activity/task time was set to three minutes, as this seemed to allow a comfortable completion of the composition. This was a step that called for trialling and was very much dependant on the nature of the domain principles and elements that drive task/activity creation.

3a. Product generation: participant recruitment

Once the task/activity was created and the conditions set, participant recruitment began. This was a decision that was very much driven by the nature of the task. The relevance of demographic variables like age, gender, ethnicity and income levels or education were circumstantial to the practical tasks/activity that was created in the previous step. In the case of the study discussed here, the literature review showed that domain familiarity was desirable, ergo education was an essential variable to consider in the recruitment of participants. Postgraduate design students from the School of Design (various design disciplines) were asked to take part. Being exposed to design as a domain of knowledge indicated that the participants were either explicitly or implicitly familiar with the elements and principles that the practical task was built upon. This in turn implied that they demonstrated domain comprehension (as well as their own discipline specific knowledge).

According to Zelanski and Fisher (1996), control groups are usually the norm when conducting experiments in the purest scientific sense; but as this was a quasi-experimental approach, a control group was not deemed necessary. All participants were exposed to the same task, and there was no before and after measurement scenario.

Once this step has been completed, and the CBoard© activity conducted, new products were generated. In the case of the CBoard© activity a total of 65 responses were collected. The number of responses was not however set in stone as it was very much dependant on the nature of the task and the number of domain principles and elements that lead to the creation of the task. The question of what is the appropriate number of responses that should be generated has been previously debated in the literature. Amabile (1996) gives examples that range from 22 to 15,000 when computers were used to evaluate certain aspects of musical products. A reasonable spread of responses were obtained and prepared for the next step.
Once a new product had been collected and photographed the response was digitised and prepared for the next step. This meant that the first part of the hypothesis had been completed. The following steps will address the measurement of the depended variable, which in this case was flexibility.

3b. Product judging: participant recruitment

In the previous section, the discussion on participant recruitment has addressed the importance of the student’s familiarity to the domain. Domain experience was also a factor in the recruitment of those who would judge the CBoard© products created by students. In this case, the decision to recruit judges with domain expertise was a direct result of the literature review. The debate on the question Creative according to whom? is still on-going, however the balance seems to be shifting towards valuing the opinions of those with domain expertise over those without it. According to Hayes (1989) it takes around five years of experience in the domain for an individual to be considered a quasi-expert and ten years’ experience to become an expert. Conditioned by the domain experience variable, design academics with both five and ten years of experience were recruited and asked to judge the responses produced by following a structured protocol that will be discussed in the following section.

3c. Setting up judging protocols

To ensure that judgments were conducted following a procedure that would yield a creativity score that could be later on validated, the Consensual Assessment Technique (CAT) developed by Teresa Amabile (1982) was proposed. The technique developed by Amabile (1982) was aimed primarily for creativity measurement in social psychology. The method was founded
on the presumption that experts recognise creativity when they see it. If they agree that a product is creative, then it must be true. (Amabile 1982). However, in order to use this judging protocol as part of the quasi-experimental procedure proposed here, a number of procedural requirements had to be met:

a. **Requirements related to the practical task:** according to Amabile (1996) the task must lead to the generation of visually observable responses that can become objects of assessment. The task should be open ended enough to allow the generation of more than one response and if circumstantially possible, this should not be highly dependent on special skills such as ‘drawing ability’.

b. **Requirements related to the judges:** Amabile (1996) notes that expertise in the field should not be identical, but the judges should be all familiar with the key domain principles and elements. This can be presumed true after the first five or ten years in the domain (Hayes 1989). The assessment of the products has to be made independently and agreement must be achieved without the opportunity to influence one another. Another essential condition expressed by Amabile (1996) was the issue of relative judgement, as the judges should rate products relative to each other and not against an absolute standard. Lastly the products must be always presented to the judges in a different random order.

To contextualise this within the study discussed here, the task conditions have been met as the CBoard© allowed the generation of more than one observable response. Furthermore, the task allowed the manipulation of design principles and elements that the participants were familiar with, and the completion of the CBoard© was not dependant on special skills. In regard to the secondary conditions, the judges were design academics recruited from Design Schools, hence with domain knowledge and with different levels of expertise (quasi-experts and experts). These judged the CBoard© responses independently, relative to each other and in random order.

**Step 4 | Data collection**

In order to facilitate both data collection and the judging activity, an analogue sorting scale was proposed. Noted by Amabile (1982), judging can be assisted by using a five point Likert Scale and asking participants to assign and score each response according to a category. These would range from one to five as follows: very uncreative (1), rather uncreative (2), undecided (3), rather creative (4), very creative (5) (Amabile, 1982). Judges were asked to categorise their responses while being video recorded. As the study was not intended to be purely quantitative, the design academics were asked to ‘think out loud’
and justify their choices. This was an important step in the research project as it allowed the collection of richer data that was qualitative in nature. This was hoped to provide answers not only towards which responses are creative but also why are these considered so. The ‘think aloud’ procedure will be further explained in the following section.

4a. Think aloud

Original to experimental psychologists, the think aloud method is defined as a verbalisation of a thought stream (Eccles and Arsal 2017). Often overlooked by qualitative researchers, this method could offer some insights into the cognitive process that take place when a participant is faced with a task or activity. For example, Eccles and Arsal (2017) used the think aloud method in order to recognise thinking patterns by asking golfers to verbalise their practice. These speech patterns allowed the observation of the golfer’s thoughts, leading to the extraction of valuable insights. In the context of this study, the think aloud method was seen as an appropriate way to deliver a qualitative dimension to the project. Once given the analogue Likert Scale, the design academics were asked to categorise the responses but also justify their thinking, ergo their internal decision-making process. Given the difficulty of the topic, prompts were prearranged in order to facilitate the judging activity and to ensure that the think aloud method would yield rich data. These took the form of questions such as: what makes that response rather creative? or what made you place the response in that category? These questions were not set in stone and were adapted according to the participant’s willingness to think aloud. The prompts were used to slightly structure the judging process as well as encourage thought processes verbalisation. To facilitate data collection, a product/response template sheet was created in order to capture the design academic’s responses. These were also used as contingency measures in the case of video recording failures. An example of a data capturing sheet can be seen below.

![Fig. 4. Data Capturing Template Sheets (Author’s own 2018)](image-url)
A total of 85 design academics judged the 65 products/responses. This in turn lead to the next step: data analysis procedures.

**Step 5 | Data analysis**

In the case presented here, two sets of data have been collected. On one hand, quantitative data, in the form of scores ranging from one to five, and on the other hand, the qualitative data in the form of the think aloud verbalisations. In order to analyse both sets of data and address the question of agreement between the judges, the quantitative data was subjected to factor analysis, while the qualitative data agreement was organised following the Q-Method. Both analytical approaches will be discussed and exemplified below. The overarching aim was to identify if the judges agreed with each other when scoring the CBoard© products and what were the reasons behind their judgements.

5a. Cronbach alpha

To assess the extent to which different raters/observers gave consistent estimates to the same activity, inter-judge agreement scores were extracted. These have been obtained in the past by using the Cronbach Alpha (Cronbach 1951) factor analysis (Stephanic and Randles 2014). While true or absolute consensus between judges is not entirely possible, an adequate inter-agreement score should be no lower than 0.70. In the case of the study discussed here, each judging activity outcomes were prepared for SPSS. The 65 CBoard© products showed agreement scores that ranged between 0.45 and 0.83. Out of the 65, 47 showed inter-rated agreement that was above 0.70. Consequently, only these were qualitative analysed following the Q-method procedure explained in the next section.

5b. An adapted Q-method

Developed in 1953 by William Stephenson, the Q-Method (QM) addresses the systematic study of the participants’ subjective viewpoints (Watts and Stenner 2012). The individuals sort a set of items according to their internalised thinking and emotional processes. Following the QM, these are compared and contrasted with the aim to find groups of people who share the same viewpoints on a topic. As noted by Q-Method.org (2018), this is a data reduction exercise. Using an analogue procedure or dedicated software, the data could be reduced to a number of shared viewpoints. This should allow the identification of patterns within similar viewpoints in order to conclude and recognise a shared viewpoint. The QM ultimately leads to an understanding of the variety of shared viewpoints on a given topic. In order to contextualise this, a CBoard© product will be used as an example. The picture seen here achieved a 0.79 inter-rater agreement. Most design
academics placed the example in the rather uncreative category giving it a score of two.

The participants made 37 statements related to this response. Among these, design academics mentioned that the response was *rather unbalanced, too easy, too predictable* or *too symmetrical*. After sorting these responses, three main categories became apparent: *boring, symmetrical* and *predictable*. Out of which *predictable* was the viewpoint that most commonly described the response used here as an example. The following conclusion was then made. This response was therefore considered rather uncreative (2) because it was predictable. The next and the final step encapsulate an amalgamation of all the data set gathered as a result of an experiment.

**Step 6 | New products creativity measurement sheets**

A visualisation of the results of the experiment was needed in order to present findings holistically, conclude on the hypothesis and complete the research circle. This was done by compiling a list of the products generated with the use of the CBoard© task/activity, presenting the agreement scores and consequently the viewpoints. Following the quasi-experimental methodology proposed here, testing the hypothesis was possible. At this point in time, employing the conditions presented in this paper, it could be tentatively concluded that creative flexibility can be accurately measured if the openness of the task is controlled. Given the controlled nature of the approach proposed here, quantification of creativity can be achieved with this methodological approach. The scores are the result of a controlled task that specific participants responded to. Particular participants have judged
the newly generated products and agreement between them was used to discuss result validity.

In order to make this methodological approach a mixed method in the purest sense, the qualitative data will have to be further interpreted. A follow up study would be needed to further develop the viewpoints. For example, in practical terms in the context of the task, what does predictability mean? Could it mean that one of the design principles or elements, like space or proportion was not manipulated enough or too much? Broader questions could also be further explored such as Could these responses become performance indicator? or Would a score of two mean that the individual does not have an ability to modify thinking therefore meaning that he/she does not show creative flexibility? or Does that mean that he/she does not have the capacity to be creative? These are still questions that need answer, however the proposed methodology could possibly be a way to keep the discussion on methodological rigour when studying creativity outside psychology open.

5. Concluding remarks

The approach proposed here does not claim to take an experimental or psychometric approach that is pure to the domains that most often use them, but to borrow from these with the intention to show a simple, step-by-step model. The paper suggests an attempt to methodologically understand how to answer the two main questions in the field: what is creativity and how could it be measured? A multidisciplinary form of mitigating and understanding creativity is arrived at, by controlling some of the controversial and subjective aspects that often led to disagreement. To say that the method proposed here is the ultimate measure of product creativity is not possible. This paper does not intend to offer an absolute solution to the study of product creativity measurement, but it hopes to start a conversation that exists outside psychology without compromising on research rigour. The story of creativity measurement is a challenging one to tell and it is more multifaceted than expected. In the space where this research exists and in this moment in time, the results do appear to show that a compact, methodological research circle could be achieved by adapting a quasi-experimental research approach. By using this methodology, the results of this research seem to confirm that creativity could be understood by observing products generated by a domain restricted task and by listening to what experts and quasi-experts have to say. The crude reality of creativity research is that, while fascinating, it is riddled with assumptions that could be perhaps interpreted as shortcomings. Partly due to the lack of a universally accepted theoretical grounding, conducting creativity research is methodologically challenging. The need for multidisciplinary methodological approaches is desirable and collaboration with psychologists is perhaps essential in order to ensure validity, translate and apply different research practices across different fields. This could be
perhaps an opportunity for psychologists and domain specific researchers to collaborate. Non-psychologist researchers could use their domain specific expertise to develop tasks/activities/stimuli while psychologists could use their expertise to ensure methodological rigour.

The battle to elucidate creativity is nowhere near over. Having a method to measure creativity could be of importance. Quantifying creativity could have great advantages, as being aware of a creativity quotient could be a pathway towards improving creative strengths. Quantifying creativity, either by employing the methodological approach proposed here or by following the psychometric approach could possibly yield practical insights into what is creativity and how it is in perceived in a domain of knowledge.
Creativity as a research topic has not reached a saturation point and opportunities for further research clearly exist. The direct effect of domain specific tasks/activities on a creativity construct like flexibility are worth exploring more in order to make plausible conclusions that could have a direct impact on real life and the Creative Economy. This research did not deal with the full complexity of the two main questions that are driving the field: what is creativity and how can we measure it? This research advocates that creativity is fundamentally a multi-faceted object of investigation. In order to understand it, researchers could consider working towards a simplified understanding. The quasi-methodological model proposed here is an attempt to add to the body of knowledge by demonstrating that it is possible to conduct a creativity research in a domain other than psychology. Making plausible assumptions that can be translated and directly applied in a domain of study like design could also mean that the methodological approach could be replicated in similar domains such as fine arts. The research methodology proposed here could possibly be replicated, as other tasks or activities could be created according to domain specifics and judging protocols and data analysis procedures followed as per the proposal. Reasonable findings could be then extracted and used to further the study of creativity on a multidisciplinary level.
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