Describing Creativity in Design Across Disciplines

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Abstract: Creativity is an essential aspect of design thinking. Being able to describe creativity and creative processes is important for developing future designers. While much research has been undertaken describing creativity in design, there is very little investigating how creativity and creative thinking varies across disciplines. A coding scheme involving six separate codes was developed initially from the literature, refined and then used to describe how creativity and creative thinking was apparent in the DTRS 10 datasets of Junior Industrial Design, Graduate Industrial Design, Mechanical Engineering, Choreography and Entrepreneurship. Based on this analysis, conclusions on how creativity and creative thinking varied across the datasets were also reached. It was found that while all datasets analyzed included Process, Product and Press codes, how these were identified in the data varied. The three Personal codes were only identified in three of the datasets. This research has implications for investigating how to develop creativity and creative thinking skills in all designers.

Keywords: Creativity, variation, design thinking, disciplines

1. Overview
Creativity is an essential aspect of design thinking. While creativity and the creative process often have similar characteristics in design, how it is enacted across disciplines varies. This is often due to the disciplinary design traditions that have formed the accepted practices within that discipline, or is related to the types of work situations those designers find themselves in. However, it is argued that discipline specific design thinking skills related to creativity can be strengthened by looking across these disciplinary boundaries, to learn from other disciplines.

This paper investigates and describes creativity in the DTRS 10 dataset. Specifically, we were interested in identifying and analyzing creativity across the different disciplines present. While Williams et al (2010, p115) argue that “Creativity [is a] combination of novelty and value; it is not a discipline-specific phenomenon”, we argue that creativity will be seen in different ways across different disciplines. This could be due to the disciplinary training, disciplinary norms, or the types of people that are attracted to different disciplines.

The research questions that drove our analysis were then:
1. How can the creativity in the dataset be described?
2. What is the variation of creativity between the data sets?
To answer these questions, we looked at the Junior Industrial Design, Graduate Industrial Design, Mechanical Engineering, Choreography and Entrepreneurship datasets in (Adams & Siddiqui 2013). A coding scheme was developed based on creativity literature, and used to identify different aspects of creativity in the datasets. This was then analyzed to identify and describe the variation across the different datasets, particularly looking at the prevalence of different codes in the various data.

2. Theoretical Framework

Creativity is often described as an abstract, objective phenomenon, but is also regarded a phenomenon embedded in personal experience and subjective practice (Williams, Ostwald & Askland 2012, p6). Treffinger et al. (2002) think, “because creativity is complex and multi-faceted in nature, there is no single, universally accepted definition”, but many different ones. Creativity can be expressed in variety of ways and so does the description of it. It is often defined as the ‘development of novel and appropriate solutions to problems’ (p9). Much of the research that exists on creativity in design and design thinking is dependent on the specific authors focus on either the design methodology, the design product, the designer themselves, the design process or the use of knowledge based systems.

Creativity in design often appears as a ‘creative leap’ whereby the designer realises a significant insight in the design. Dorst & Cross (2001) argue that in every design project creativity can be found, if not in the form of a specific creative leap then as the “evolution of a unique solution possessing some degree of creativity” (p425). Defining and framing the design problem is a key aspect of creativity (p434). Creative design involves the co-evolution of both the problem space (framing and defining the design problem) and the solution space (all the possible solutions). Creative leaps exist in the solution space, but are often a result of a reframing or further defining of the problem space.

Creativity is evident in four ways: in the creative product, the creative process, the creative person, and the creative situation [or environment] (Williams, Ostwald & Askland 2010, p115). This is based on a classification scheme for creativity coined by Mel Rhodes (1961) involving 4Ps: Person, Product, Process and Press. “The 4Ps represent the nature of creative Persons, the Processes they use, the Products or outcome of their efforts, and the Press, or environment that supports or hinders creativity” (Fox 2012). Press is from the Latin meaning box or container, akin to the environment in which the designer finds themselves, and can be thought of as the elements in that environment that help or hinder them. “The four strands overlap and intertwine, and it is through their unity that ‘creative processes’, ‘creative problem solving’ or ‘creative play’ take place […] through their interconnection, design creativity may emerge” (Williams, Ostwald & Askland 2012, p13).

The 4P’s can then be described in more detail as:

1. Persons (designer, client (user), instructor)
   a. Internal feelings (intuition / temporary) - emotions
   b. Sudden creative insight / illumination / improvisation
   c. Personal traits (background of the designer/permanent) - cultural background

2. Processes
3. Products
   a. Novelty of Solution - historical & psychological
   b. Usefulness / Utility of Solution
      i. User interaction - ergonomics
   c. Relationship between Aesthetics / Form and function

4. Press (environment)
   a. Time pressures & deadlines
   b. Support & interaction with instructor & clients
   c. How the brief structured (nature of the problem)

In addition to 4Ps of Rhodes (1961), D. J. Treffinger (1988) introduced the COCO model to increase and develop creative thinking in classrooms, besides recognizing the creative potentials. COCO is interpreted as Characteristics, Operations, Context and Outcomes. According to this model, he defines “characteristics” by personal characteristics, which matches with the “Person” of 4Ps. “Operations” are explained by techniques used for generating and analyzing ideas, problem solving, decision making and thinking management, which meets the properties of “Process” of 4Ps. Similarly, “context” involves the culture, the climate, the situation dynamics and the physical environment where the operation takes place, which is actually “Press” of 4Ps. And lastly, “outcomes” which are the resulting products and ideas of people match with “Product” of 4Ps (Rhodes, 1961; D. J. Treffinger, 1988).

This was also expanded to include the work of Cropley & Cropley (2010) who extended Rhodes initial 4P’s to 6, breaking the initial Persons into three new areas of Personal Properties (or personality), Personal Motivation and Personal Feelings. Although 4Ps have been adopted by many researchers, some have argued to consider aspects of ‘person’ separately (Cropley & Cropley 2010; Williams, Ostwald & Askland 2010). Piirto (2011) describes five core attitudes of creative people possess: Self-discipline / motivation, openness to experience, risk taking, tolerance of ambiguity, and group trust. Based on the work of Cropley and Cropley (2010) a revised 6Ps framework was used in this analysis.

The 6Ps described by Cropley and Cropley (2010) are:
   1. Personal Properties
   2. Personal Motivation
   3. Personal Feelings
   4. Processes
   5. Products
   6. Press
In order to be innovative, the required **Personal Properties** are described as tolerance of ambiguity, open-mindedness, flexibility, independence, non-conformity and inner-directedness (Cropley & Cropley 2010). ‘Openness to experience’ is seen as one of the core attitudes of creative people paying attention to small things, to notice differences and details and the ability to see old things like new. It’s a way of seeing things as if they have never seen before (Piirto 2011). Tolerance of ambiguity is defined as the ability to act without knowing the right answer and without depending upon an authority, and it is essential to not to focus on only one solution but to search more (Piirto 2011).

**Personal Motivation** was first proposed by Cropley and Cropley (2010), and is defined by Piirto (2011) as “the core attitude of self discipline and motivation” of creative people. A person is driven by the urge to push ahead, to take risks, have a drive to seek the new and surprising ideas and the urge to generate variety (Cropley & Cropley 2010). A creative person is expected to take risks and try new things. Personal motivation leads to a self-discipline, and self-discipline leads to productivity (Piirto 2011). Self-discipline is only possible with motivation. It helps the person not to stop but generate alternatives and develop ideas until reaching a satisfying result.

A variety of **Personal Feelings** are listed by Cropley and Cropley (2010) including pleasure in finding a novel solution, excitement when facing uncertainty, optimistic way of looking to problems, desire to do more when feeling successful and enjoying the challenge in case of unsuccessful situations. Even though it is believed that positive mood encourages creativity, there are other factors, such as timing, effecting mood-creativity relationship; a positive or negative mood shows an effect depending on the which part of the creative process they are immersed. Positive moods lead more creativity if the context is framed enjoyable rather than seriously (Cropley & Cropley 2010).

**Product** is the “production of original and useful work” (Williams, Ostwald & Askland 2010, p6). It is “novel, elegant, seminal and germinal” (Cropley & Cropley 2010). Product is considered as the final outcome of the design process.

**Process** involves “conceptualizing a situation broadly, asking unexpected questions, making remote associations, seeing unexpected links, finding problems, restructuring problems, generating solution criteria and communicating a situation to others in a loose and general way” (Cropley & Cropley 2010). It is the time between the problem is given and the final outcome; in other words, process is the person’s journey throughout the designing activity until creating a product. In process phase, the thinking, the ideation and inspirational information can be examined. Recent work by Daly et al (2012) has identified a number of concept generation processes that help designers create new ideas.

**Press** refers to environmental factors providing opportunities for creative thinking. It is first of all related with how the brief is structured, the initial description of problem space. It refers to time management to finish the project in time by allowing creative moments. It can also be read through interaction with instructor and clients such as supportive and constructive or destructive critics from them. Whether they are allocating time for creative thinking during juries is considered.
3. Methods & Data
The analysis method we adopted for this paper involved developing an initial coding scheme based on the literature around creativity, testing and refining this coding scheme with one set of data, followed by a final coding of the rest of the data with the refined codes. We developed an initial coding scheme based around the 6Ps of Cropley & Cropley (2010). This was used as the framework to also include other aspects of creativity identified by Cross (1997) around process creativity, Sarkar and Chakrabarti (2011) around product creativity, and Cross (2002) around persons and personal traits. Finally Piirto (2011) was used to frame the Persons code further.

For the analysis we decided to only look at the transcriptions of the meetings, as we were interested in how creativity could be described through the discussions students had with their instructors and clients. We acknowledge that this gives a partial picture of creativity, as many people report that creativity happens in the mind or between times, however we were interested to see what the data could tell us about explaining creativity.

The first step in the coding scheme involved coding the IDJR dataset against the initial six codes. Each of us (the authors) coded Sheryl and Todd’s datasets independently, firstly identifying utterances in the transcripts we believed were associated with creativity and then identifying if they were examples of one of the three persons codes, the process code, the product code or the press code. Once Sheryl and Todd’s datasets were coded we came together to discuss our coding’s, looking both at what we identified in the transcripts related to creativity, as well as what code we gave it. Each disagreement we discussed why we coded it in the way we did, and tried to reach a consensus for future coding. These decisions were then recoded as detailed descriptions of the codes (forming an informal code book).

Once the initial discussion and verification of the codes was done, we then coded the rest of the IDJR dataset (Addison, Adam, Alice & Esther). Specific clauses, phrases or sentences were coded, varying in length from a few words (“It's a bird in the snow” Addison IDJR meeting 3, p2) through to longer multiple sentence statements. When we disagreed, we then discussed what we saw and why we coded the statement in the way we did, aiming for consensus. In all cases of initial dispute a consensus was reached, and the discussion and decisions recorded. This formed the basis for the subsequent data coding.

The Mechanical Engineering data set was coded next, and the coded data once again discussed along with the prevalence of codes. Refinements to the coding scheme were also captured where we had to expand our initial understanding of the codes. This expansion also pointed to a source of variation among the datasets. For instance as a result of the Mechanical Engineering dataset, the product code was expanded and refined. Next, the Graduate Industrial Design data set was coded and the coded data discussed, along with the prevalence of codes. Finally the Choreography and Entrepreneurship datasets were coded.

4. Creativity in the datasets
The coding scheme was used to describe creativity in each dataset across the six codes of Personal Properties, Personal Motivations, Personal Feelings, Process, Product and Press. Across all the datasets, the three Personal codes were not very apparent, while the other three codes appeared often. When the Personal codes were identified, they were either students or instructors
explaining how they felt about different options, or statements about the students themselves. The Process code was associated with students explaining how they came up with their ideas, while the Product code became associated with the novelty or ideas embedded in the solutions generated. Finally the Press code was mainly identified in the environment the instructor was providing to the student, either in the feedback and encouragement they were providing directly to the student or in the way they set up and influence the design brief.

4.1 Industrial Design Junior
The Industrial Design Junior was the first dataset analyzed. While only a few Personal codes were identified, they mainly involved either the student describing their ideas or the instructor guiding the student. For example, the few Personal Properties identified were either the client or the instructor engaging with the student as a designer:

“I personally, ah, in my heart of hearts, I, I just love the, ah, I just love the uniformity.”
Adam IDJR, meeting 5, p3.

“You're the designer. Which, which do you think?” Sheryl IDJR, meeting 2, p4.

Personal Feelings were often identified when the students were describing their ideas using emotive language:

“It just brought the office more live and it made it a more fun and enjoyable environment” Addison IDGR, meeting 5, p1.

“I'd say these two I'm more passionate about.” Adam IDGR, meeting 2, p7.

As the dataset contained both instructor and client reviews, there was a lot of opportunity to look for how the students described how they were developing their ideas. As such, there was a large focus on the Process code, either in students describing their own mental processes:

“I wanted the form to be able to define the structure.” Addison IDJR, meeting 3, p2.

“This is the inspiration I pulled from it, really looking at different shapes and, um, really just the aesthetics and then how functionable it is and how much you can use it.” Sheryl IDJR, meeting 3, p1.

Or looking at what competitors were doing for inspiration:

“So I started out just like everybody else looking at current perches and stools that are out there” Addison IDJR, meeting 3, p1.

“Go to what competitors have done, especially good ones, and you can borrow some of their research look at the scale and dimensions” Adam IDJR, meeting 2, p1.

The Product code was identified when students were discussing a particular new idea in their designs:
“I really wanted to look at form and I wanted to create a form that was interesting and different… But you can sit on it. It has different heights. It's lower here. It's taller in the back. It's still pretty stable. You can sit on it this way. You can rotate on it” Addison IDJR, meeting 5, p1.

“I was thinking that these little cutouts you could take out and you could either put like a notebook on it or there’s even a little shelf space underneath you could store things right there.” Adam IDJR, meeting 3, p2.

The Press code came only from instructor Gary, but in a way that encouraged the students to explore different options:

“When you're presenting, too, that's another thing you can say, ‘Listen, it's, ah, say you wanted to, to look at – you looked at the competitive products and, ah, you didn’t want another ‘me, too’, like you want something original.”” Todd IDJR, meeting 1, p5.

As well as setting deadlines:

“I'd put together a schedule working back from Thursday or Friday.” Adam IDJR, meeting 2, p8.

“Don’t have an insane Thursday night, let that be Tuesday or Wednesday night so you can come in on Thursday and talk about getting your presentation together.” Alice IDJR, meeting 2, p12.

4.2 Industrial Design Graduate
The Industrial Design Graduate dataset again had both reviews with the instructor and client. As with the Junior Industrial Design, the Process code was most prevalent, followed by the Product code. Press again was provided by the instructor but in an open way. Only a few Personal codes were identified.

When Personal Properties were exhibited, they were generally the instructor encouraging the students to push themselves:

“Um, I think they really want us to scare them with crazy, wild ideas, so don’t be afraid to let yourself go wild and crazy in your ideations, okay.” Mylie-Dan IDG, meeting 1, p20

The few cases of Personal Motivations in this dataset involved either the instructor motivating students:

“don’t be afraid of challenging social norms, okay” Simon IDG, meeting 1, p2.

Or the clients providing motivation:

“That’s a good way to think and a good way to design.” Eva IDG, meeting 3, p8.
Some of the Process code involved the ways the students went about doing the D-search review:

“So you did an empathic research, taping your joints and putting Vaseline in your glasses so you could – what was it like?” Allison-Jin IDG, meeting 1, p1.

“There’s not a designated space for storage, legibility of the different bottles and clothing tags. And then also the laundry room is usually dirty, messy.” Allison-Jin IDG, meeting 1, p9.

“Another thing that I thought was very interesting that she pointed out was the fact that she hates the fact how everything at the Laundromat is white.” Mylie-Dan IDG, meeting 1, p8.

While others described user processes they needed to incorporate into their thinking:

“Before laundry, uh, yeah, um, you need time. You need time to organize the clothes before carrying the clothes to the laundry room and, um, before you put the laundry on” Sydney-Eva IDG, meeting 1, p13.

The Product code described the various ideas the students had come up with, particularly to cope with the usability issues they identified in their D-search:

“So my concept ... for these people who have special needs, like they have to detect the smell on their clothes, even it’s very, uh, little, tiny smell, like the smell of sweat, smell of cigarettes and the smell of humidity and the smell of pet” Eva IDG, meeting 3, p2.

“Like there’s something very cool about this, especially since we travel so much.” Sydney IDG, meeting 3, p2.

The Press code again was evident in the ways the clients and instructors gave the students feedback on their ideas in positive ways, and encouraged them to be creative:

“I really appreciated having the multiple interviews and the in-depth interviews that you did.” Allison-Jin IDG, meeting 1, p12.

“But they are beautiful drawings, really nicely done. Love the vignette and the way these two drawings are tied together with that vignette. It does a really nice job of showing that.” Sydney IDG, meeting 2, p1.

“Let yourself go and kind of come up with some stuff that’s so far out there that they’re going to go, ‘Whoa, these people are on some sort of drug’ and some things that are like, ‘Yeah, we could do this tomorrow and it’d be no problem and it’d be real handy for everybody to have.’ ” Simon IDG, meeting 1, p1.

4.3 Mechanical Engineering
The mechanical engineering meetings were quite different from the other datasets, emphasizing the development of a specific product design. We identified far more Product codes than Process
codes, with the Press code again mainly provided by the instructor. No Personal codes were identified in the ME dataset.

The few Process codes we identified were mainly to do with refinements in their design using mechanical analysis processes:

“After going through our design and tweaking that a little more, we realized, um, having the shaft locker mounted to the, um, non-rotating plate would cause a problem” Cap Team ME, meeting 1, p4.

“We did several analyses to determine the size of the angle lead piece, and, ah, added a brace at the end to change” Prop Team ME, meeting 1, p4.

“could you shave some weight out of it by doing a structural analysis” Prop Team ME, meeting 3, p7.

“the design analysis for on one of the most important things for us is to make sure that we can open the jar, because if we’re not able to do that, our project is basically a failure because anything else we do after that point doesn’t really matter.” Cap Team ME, meeting 1, p9.

Most of the Product code deals with describing aspects of the final design concept:

“The electrical components aren't gonna be actually on the assembly because we don't want any components or batteries being near an explosion because that could cause it to be dangerous.” Cap Team ME, meeting 1, p2.

“Our customer told us that he wanted us to make an assembly that would allow for him to inject water after he would open the jar, to neutralize the powder and make it safe for him transport and move around.” Cap Team ME, meeting 1, p6.

“We chose the shape of our fin through previous research that was done through other universities. And that’s how we chose the crescent shape and then the width of the fin itself” Robot Fish Team ME, meeting 1, p4.

Press is again identified from the feedback the instructor provides but in a controlling and negative way:

“Okay. Before we go further, we have a unit that's not fully assembled, and we have a unit that's not functional. Do you really wanna go on at this point?” Cap Team ME, meeting 2, p2.

“So I've got a question for you, since you're – half of you are celebrating over here. I assume you think that means you passed.” ME, meeting 4, p1
“I didn't grade on your schedule being red, because I anticipated that and I want to make this point because I want to give you the best service I can for your next job. That's really where I'm going with this.” ME, meeting 4, p5.

4.4 Choreography
We analyzed ‘Choreography’ with the coding scheme refined after IDJR, IDG and ME. We looked at Anita’s and Carol’s transcripts only, in order to describe ‘creativity’ from the perspective of students, and during the interaction of the students and their instructors. The coding scheme had to be refined somewhat as the codes of product and process were exhibited differently in Choreography from the previous three datasets.

In Choreography, the instructors were mostly giving critiques and feedback using their feelings. Personal Feeling was the most preferred medium to express thoughts about the work. For example:

“Loved your opening... you have these gestures that I’m really enjoying” Anita CHOR, meeting 1, p1

“I really like your music, I really like your costumes... I love the continuous group lift towards audience” Anita CHOR, meeting 1, p2

“beautifully done, really beautiful... I was fascinated with that because the bodies are swaying and turning” Anita CHOR, meeting 1, p3

“Love the entrance again and the back and forth stuff there” Anita CHOR, meeting 2, p1

“I just thought that was really beautiful and I really – I enjoyed that a lot” Anita CHOR, meeting 2, p3

“I loved all the backwards moving through space” Carol CHOR, meeting 1, p2

If something is good about the choreography, the explanation is indicated with words like “love”, “like”, “beautiful”, “great”, “nice”, which is very different from the other datasets.

“The way her pelvis drops under as she comes down is just gorgeous” Anita CHOR, meeting 3, p13

Instructors talk about the Product as well, in this case, but not as much as how the product makes them feel. In this context, the product includes the movement of the dancers, the clothes used and the colors preferred:

“I think that the skirts have potential. I feel that the long skirt with the music that has been composed for you takes me to a Martha Graham era and that’s not bad” Anita CHOR, meeting 1, p3

“I really wanted to see more movement in her because I thought that was really cool” Anita CHOR, meeting 2, p3
“the costumes are classic and clean, don’t want you to mess it up. I wouldn’t add another color” Anita CHOR, meeting 2, p5

The Press again was exhibited in the ways the instructors provided feedback to the students. While the instructors did provide feedback about how to make the choreography better, the explanation of what needs to be done is often not clear, leaving it up to the student to interpret:

“so those things were working for me, but, but the three legs, the way they are didn’t. I was like yeah, it just doesn’t work” Anita CHOR, meeting 2, p7

“What I didn’t love was the hailing the cab moment” Claire CHOR, meeting 1, p 10

“there were some moments where I felt like the movement was calling for just a little bit more suspension” Claire CHOR, meeting 2, p 1

Finally, the students sometimes could not explain their Process, or why some things were done the way it was. Things were done intuitively:

“I don’t know, for some reason I didn’t feel like it should be somebody else at the end. It just didn’t – I had – I think I had” Claire CHOR, meeting 2, p 7

4.5 Entrepreneurship
Entrepreneurship was the last dataset to be coded, with only the presentation to experts included in the dataset (i.e. only one meeting). In Entrepreneurship, the codes of Process and Product were seen integrated together. The Product was identified in the analysis of the market and the idea generation, marketing and evaluation of the campaign, while the Process code was identified as the process of market analysis.

Most of the identified Process codes discussed the market analysis the students undertook:

“look into the market and see what our competitors are doing” ENTREP, Tumbler Team, p2

“we also went to our consumers to – and we asked them a few questions and, um, eight out of ten of them said that they do accumulate trash in their car...” ENTREP, Tumbler Team, p2

“we interviewed a lot of construction companies that said this is a huge problem” ENTREP, Tool Team, p6

“we took a look around in our daily lives and saw what, ah, bugs us every day or what problems do we see other students have that we feel we can solve” ENTREP, Cruiser Team, p1

The student groups were also very aware of targeting their market well, revealed in the product code:
“international students and a lot of other out-of-state students who were facing the same problem. We thought why not come up with a solution for that.” ENTREP, Ace Team, p1

“an average, international students spend about $150,000.00 to $170,000.00 on tuition just at Purdue. So, ah, these are the kind of students we would target because it's a premium service” ENTREP, Ace Team, p1

They were also more certain about their arguments, estimates, and assumptions to do with their Product.

“our preproduction fixed costs would be about, um, $12,520.00. And that includes a prototype, the plastic injection molded – molding, which would cost about $10,000.00” ENTREP, Tumbler Team, p3

“We do everything from picking you up from the airport, to setting up your apartment. Our experts will be available 24/7 throughout the first week, and, ah, during regular business hours to help assist you” ENTREP, Ace Team, p1

“we are here to solve the largest problems in the construction industry” ENTREP, Tool Team, p1

“it’s estimated there's a $1 billion of lost equipment each year, and in the year 2013, they’ve estimated that construction and tools, ah, budgets will increase 70 percent in 2013.” ENTREP, Tool Team, p2

Entrepreneurship students were more professionally dressed than other students in the data, pointing to a formal Press. Further, Instructors asked more critical questions (than in ID and ME) instead of developing the ideas further (like in ID):

“But in terms of finding the bike, how are you doing that?” ENTREP, Cruisers Team, p7

“And no issue with fraud or theft on, on this deal?... So what happens if I'm riding the bike and the tire blows?” ENTREP, Cruisers Team, p8

In general, we did not identify the idea generation process of ENTREP students; we could only see the final jury available in the data.

5. Variation Across the Datasets
While each of the six codes were identified in all the datasets analysed, both the prevalence of each code and how it was apparent varied.

5.1 Personal Properties
This code was observed a few times in IDJR, IDG and CHOR but not in ME or ENTREP. In the IDJR, this code was only identified in the clients or instructor as statements to the students. For instance, a client said to the student Adam:
“I personally, ah, in my heart of hearts, I, I just love the, ah, I just love the uniformity”
Adam IDJR, meeting 5, p3

or Gary the instructor saying to Sheryl:
“You’re the designer. Which, which do you think?” Sheryl IDJR, meeting 2, p4.

or to Walter:
“It’s magic – magically adjusts.” Walter IDG, meeting 2, p23.

Similarly with the IDG, this code is mainly associated with the instructors helping encourage the students’ ideas.

“Wouldn’t that be cool? The kid washes it by rocking?” Mylie-Dan IDG, meeting 1, p18

“Um, I think they really want us to scare them with crazy, wild ideas, so don’t be afraid to let yourself go wild and crazy in your ideations, okay.” Mylie-Dan IDG, meeting 1, p20

In CHOR, this code is associated with giving emotive feedback to students:

“I just thought that was really beautiful and I really – I enjoyed that a lot” Anita CHOR, meeting 2, p3

In all three datasets where this code was apparent, it was the instructor or client providing feedback to students. We believe that the reason we didn’t see more of this code was due to the nature of the collected data being only design reviews where students are having to explain in a very short amount of time what they have done, rather than how their personal properties have influenced their design ideas.

5.2 Personal motivation
This code has been observed more than personal properties in IDJR, IDG and CHOR but not in ME or ENTREP. According to our definition of the code, we were looking at personal motivation coming from the student her/himself:

“I have more passion on this one” Julian IDG, meeting 4, p4

It was also seen in the statements being given to the students to motivate them from either their instructor:

“don’t be afraid of challenging social norms, okay” Simon IDG, meeting 1, p2

“This is the essence of what I want to do to be passionate about it. Again, you’re the designer” Alice IDJR, meeting 2, p6

or client:

“That’s a good way to think and a good way to design.” Eva IDG, meeting 3, p8
Again, the reason why this code was not more prevalent could have been the nature of the dataset being analysed. This code may have been seen more if students were asked more about how and why they came up with the ideas they did.

5.3 Personal feelings

This code has been observed in CHOR and IDJR but not in ME, IDG or ENTREP. In IDJR, students and sometimes the instructor and clients show feelings (mostly related with liking or not liking the product) without any reasonable explanation.

“when you look at it you want to touch it, you want to feel it, you want to sit on it, and it’s fun and it’s a little bit more out there” Addison IDJR, meeting 3, p1

“I like the radius. It's really, really nice.” Sheryl IDJR, meeting 4, p4

“that's kind of when I first saw it, it was pretty refreshing” Esther IDJR, meeting 4, p4

In the CHOR this code was most apparent in the ways the instructors were providing feedback to students in emotive ways:

“I just thought that was really beautiful and I really – I enjoyed that a lot” Anita CHOR, meeting 2, p3

This code was more prevalent than the other Personal codes, particularly due to its large use in the CHOR dataset.

5.4 Process

Process involved a lot at looking what competitors were doing, particularly in the two ID and the ENTREP datasets. This code was the most prevalent in all five data sets analysed, in particular the two Industrial Design groups. This code was identified in the ways the students would describe the creative processes used to come up with their ideas. It is interesting to note that this code more than the others had the most identified variation within it, mainly linked to the different formal processes used in idea generation:

Prior art: “I looked at your competitors. I also looked at yours. And I looked at designers” Alice IDJR, meeting 5, p1.

First principles: “It's gotta meet the functional requirements first. Keep it simple.” Todd IDJR, meeting 1, p12.

Analogy: “We still want it to move like a fish, look like a fish, avoid obstacles.” Robot Fish Team ME, meeting 1, p2.

“inspired by mushrooms” Esther IDJR, meeting 3, p1

“and it becomes like uh peacock feathers / here's like an ice cream cone” Todd IDJR, meeting 1, p2
Shift between problem / solution: “Like a dog chasing his tail” Addison IDJR, meeting 4, p9.

Combination: “be removable from this as well, kind of what you did with the third concept so now you can remove the cushion, flip it over, sit on the cushion, use this potentially as a writing surface” Adam IDJR, meeting 3, p3.

In ENTREP, this code is only linked to students undertaking a market analysis:

“look into the market and see what our competitors are doing” ENTREP, Tumbler Team, p2

We argue that the prevalence of this code particularly in the ID datasets is linked to the formal training the student’s receive.

5.5 Product
This code was the other most prevalent in the data analysed, and was used in describing the novelty or creative ideas in the designed product.

“I really wanted to look at form and I wanted to create a form that was interesting and different” Addison IDJR, meeting 5, p1.

“combine fitness equipment and a washing machine” Sydney IDG, meeting 3, p1.

“Our customer told us that he wanted us to make an assembly that would allow for him to inject water after he would open the jar, to neutralize the powder and make it safe for him transport and move around.” Cap Team ME, meeting 1, p6.

In all cases, students were describing their design solution as a whole, or novel aspects of their design.

5.6 Press
In our coding scheme, the significant effect is actually coming from the instructor for our 'Press' category. Instructor’s attitude towards the students, his definition of problem, his way of listening and criticising students, his openness to novelty or ambiguity are all the factors that effect student creativity positively or negatively. How he motivates and supports students and helps developing the project have a big influence in fostering creativity.

“Let yourself go and kind of come up with some stuff that’s so far out there that they're going to go, “Whoa, these people are on some sort of drug” and some things that are like, “Yeah, we could do this tomorrow and it’d be no problem and it’d be real handy for everybody to have.” Simon IDG, meeting 1, p1

However there are some more strict critiques coming from the instructor, especially in ME and CHOR:
“If I was in industry and you were working for me as program manager, you'd only do this once, and then I would not allow you to be in that position again” ME, meeting 4, p8.

“There was a moment when they all lay on the floor with their butts toward us and their skirts fell down and we were just looking at their butts and crotches that I didn’t really think was good. It took me out of the piece” Anita CHOR, meeting 1, p10

It is also seen in recommendations by the instructors to students on how to manage their time.

“we’ve got five concepts by next week. Then we narrow it down to three. And then you've got a week to do better” Todd IDJR, meeting 1, p5.

“One full weekend, and the one full Thanksgiving week, and then that's it 'cause, you know, you're gonna need the beginning of the first week to finish up your electronic presentation” Todd IDJR, meeting 4, p7.

5.7 Variation in General
In general there were some differences in between the creative processes of different classes, which we observed from the datasets.

In IDJR and IDG, the instructor guides the students and asks questions. Then students can respond, or if they do not know the answer, they are relaxed enough to confess that they do not know. In general ID classes, students are still in the phase of learning during the critiques and the idea generation phase continues. The instructor and students are working collaboratively toward the client presentation. ID instructors talk a lot to explain their ideas. They are developing the idea together with the students. In ID, the instructors are more interested in the process, in ‘how’ the project is solved, where the students got their inspiration.

However in ME classes, the instructor usually asks questions about technical requirements. He is more interested in if the product is actually working and functional or not, instead of ‘how’ it was developed. During the sessions, students talk more and explain their work. There is not much learning during the classes, as students are expected to know or have solved things already. There is more pressure from the instructor when compared to ID instructors.

In CHOR, the instructors are supportive and encouraged by the student’s work. They are interested in working with the student to develop their choreographies. However they are also not often direct in how to change the student’s work, only what doesn’t quite work. The instructors and students seem to be on an equal level, seen by the instructors also providing choreographies to critique via peer review.

Finally in ENTREP, even though the only dataset available are the student’s final presentations the mood is collegial, with the experts providing feedback to help the students learn. In terms of creativity, they were always talking about the final facts and the truth, with not alternatives or possibilities. For example, ID students were offering new ways of use for an object, many points
were open discussion (mostly in IDJR, because they were novice) we don’t see it here. But in ENTREP everything is already fixed and placed, and there is not any point open to discussion.

Another distinction is between the instructors’ ways of giving critiques and feedback. In ID, although both instructors are giving motivation to the students, IDJR instructor listens and directs more by making the students explore and come with ideas, whereas IDG instructor is more involved in idea generation process and he himself sometimes comes with wild ideas. Both seem to trigger creativity in different ways though. Another difference is in IDJR instructor gives in depth critiques in a one-to-one relation setting, however the IDG instructor does the critic sessions in a more relaxed and friendly environment. He is asking other students’ opinions, so everyone is involved in giving critics. But the influence of this difference on creativity is actually not visible in the datasets.

6. Conclusions & Implications
Most studies to date on creativity in design have focused on industrial design students or professional designers. Few studies have looked at creativity across disciplines; those that have were focused on fairly closely aligned disciplines (for example Williams et al (2012) involved architecture, design, industrial design, interior design and landscape architecture). By analysing data from more diverse disciplines this research hopes to advance discussions on characterising creativity in design, which will be of use to both professional designers and also inform design educators.

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References


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