

CONSIDERATIONS ABOUT CREATIVE ENVIRONMENTS FOR STUDENTS

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Abstract: A new idea is based on old ideas and knowledge produced by other minds, but an idea is born in the mind of one person, even when working with others. This article analyses several factors contributing to people's natural creativity. Among them we find the physical environment and psychological motivations that influence the production of ideas. Additionally, some considerations on the production of ideas, creativity techniques and factors that can affect the mind are presented. Several actions based on the author's extensive experience in teaching undergraduate and graduate creativity courses are also explained. Finally, the results of two student surveys on these actions are analysed and conclusions are drawn.

Keywords: *creativity, environment, motivations, surveys*

1. Introduction

A characteristic of the human mind is the ability to come up with new ideas that are an unprecedented combination of new or known concepts. Their birth is still a mystery for current knowledge, but thanks to neurosciences, more and more is being learned about this process.

An idea is born in the mind of one person only (Weiner, 1994) even if this person is working within a group to think of new ideas. Obviously the whole group contributes to the production of new ideas, and it is a good strategy to put minds together. In fact, the same idea can be generated by different minds independently.

New ideas can appear in a range between spontaneity and hard preparative work. Also, some psychological mechanisms have proved to support the production of new ideas. A few examples include Brainstorming (Osborn, 1963), Analogy, Synectics (Gordon, 1961), Lateral Thinking (De Bono, 1970)... Some methods are based on the ordering of known ideas, like Mind Maps (Buzan, 1993) or on their combination, e.g. Morphological Analysis (Zwicky, 1969), etc. On the other hand, TRIZ (Theory of Inventive Problem Solving), by Altshuller (1990), guides the search for solutions through a small number of possible principles of known solutions, depending on the engineering parameters of the inventive problem and their contradictions.

Nonetheless, the emergence of ideas can be influenced by internal and external circumstances, independent of the use of the above tools. Some of these circumstances may be modified voluntarily by the person, for example by working within a group instead of alone, in order to obtain better results in the production of ideas.

When the mind is busy solving a problem and wants to find a solution, the idea of solution may appear suddenly. However, the final idea is usually born after some time of work, and reflection and

analysis of new solutions. Normally, a new idea stems from many old ideas generated by other minds and represents a step forward. Working in groups is a good strategy to assist in the emergence of a winning idea.

The emergence of the idea of solution generally provides a rush of pleasure, a moment of happiness or euphoria; the mind rests and a sense of peacefulness pervades us because a solution has been found, and probably something useful has been born. However, after these first sensations, the group must assess the viability of the idea and work hard to transform it into a marketed product.

The main objective of this paper is to present favourable circumstances that create a creative atmosphere, and propose motivation techniques for the development of new ideas, especially for students of technical degrees. Two courses titled *Creativity, Management and Product Innovation* (CMPI, 2012) and *Creativity, Ecodesign and Patents* (CEP, 2012) are the basis of this work. Student surveys conducted at the end of these courses were used to know the opinion of students on creativity.

2. Considerations of creativity and student creativity

Cognitive science generally aims to improve the creative process through trial and error and other methods such as tests. Also the experience of creative people increases the knowledge of techniques that promote creativity.

However, the creative process does not follow clear rules. For instance, a solution may appear suddenly or after a long time of work and dedication. Sometimes the solution is found after a period of latency or incubation of a problem over time, and this means forgetting about the problem momentarily and come back to it after a while.

Creativity is not always correlated with intelligence. Every year an anonymous test of creativity and intelligence is given to postgraduate students during the course *Creativity Management and Product Innovation* (CMPI). This test has revealed some divergence between the above mental capacities.

The general knowledge saved by students in their memory is different. A higher individual level of accumulated knowledge can generally make a person more creative. Nonetheless, this is not always the case. In the same way, the most brilliant ideas are not always provided by the best specialists.

As can be seen, the production of ideas can be a strange process, with no exact rules, due to the time of emergence of the solution, the latency sometimes required, the lack of correlation between creativity and intelligence... It is also worth noting that the best idea is not always produced by the best specialist. In the light of this, it is hardly surprising that the University currently dismisses this mental process as unscientific, showing a certain lack of understanding towards lecturers who try to promote creativity among students.

But the truth is that fresh ideas must be produced in the technical areas to provide society with new, improved products. The promotion of creative skills should therefore be a must in education, especially in post graduate curricula.

When the challenge is a problem of invention, the student's mind often searches for a new solution to the problem. But the resolution depends partially on the student's interest in the problem. At this point, several questions arise, e.g. How to motivate students to produce ideas? How to awaken their imagination? How to help them daydream or imagine in the classroom?

The following section describes factors and actions to promote student creativity based on the author's experience as part of the syllabus of two courses titled *Creativity, Management and Product Innovation* (CMPI) and *Creativity, Ecodesign and Patents* (CEP, 2012).

3. Some factors and actions to promote creativity

3.1 Personal circumstances

3.1.1 Genetic inheritance

- Our genetic inheritance probably determines the level of personal creativity, but other factors influence it as well.

3.1.2 Good health and favourable conditions

- Good health, coupled with a mind in good shape, i.e. the famous Latin phrase of Roman poet Juvenal (Juvenal, 1st century) “Mens sana in corpore sano” (A sound mind in a healthy body) and the right circumstances seem to be the basic conditions for the production of creativity. However, partial lack of the above is not an impediment to creative production. In fact, certain health problems or wrong circumstances can sometimes be promoters of creativity, as demonstrated by several examples in history, because a reaction is required. Only in extreme circumstances is the production of ideas reduced or not possible.

3.1.3 Psychological factors

- Although the right basic conditions of the body and mind are crucial for the expression of creativity, many other factors must be considered. Among them we can find the person’s degree of freedom; experiences; knowledge; degree of intuition; quantity and quality of concepts accumulated in the memory and subconscious mind; relationship with the subconscious mind; psychological pressure; loneliness; maturity; mental flexibility; curiosity; concerns; moods; relationship with others; feelings; sentimental relationships; relationship with superiors; weather’s influence; intense moments of passion or emotion; willingness or obsession to find a solution of the problem; strong wish to make dreams come true, etc. They can all influence the mind and therefore have an impact on the production of ideas.

As both internal and external factors can affect the expression of creativity, the challenge consists in providing favourable conditions for the production of ideas.

Personal conditions and circumstances are generally good for university students. They want to learn and are attending classes. This initial interest in class participation can be heightened by some actions which promote their creativity (listed below).

3.2 Acceptable environmental conditions

The lecturer should try to provide the most appropriate environment for creativity.

- Acceptable classroom environmental conditions, such as temperature, humidity, lighting, level of noise, etc.
- Adequate furniture, such as movable chairs and tables, paper and pencils, blackboard, computer, projector, screen, etc.

These conditions should just go unnoticed, much like a healthy state of the body. Note that their absence is greatly felt, becoming a hindrance to attention or creativity.

3.3 Classroom actions

3.3.1 Work groups:

- In the author’s experience, it is better to let students create their own work groups. In fact, the members of a group are often friends who work together even outside the class.
- Group participation is often more effective in producing creativity results than individual efforts. The recommended number of members is between three and five.

It must be remembered that, after all, collaborative work is an atavistic impulse.

3.3.2 Topic of work:

- The topic of work must be innovative and interesting. The lecturer can propose some general problems, such as energy or water saving, so that students think of a few simple, partial solutions. Special importance is given to the novelty of the product, which students find encouraging.
- The product to be designed or developed must be simple due to time limitations. This makes students focus on the essential.
- The lecturer recommends one or more topics but the final choice is always up to the students.
- Not only is extreme imagination, near to magic, good for creativity; the wish that a new product is useful or patentable also encourages creativity.

Production of ideas:

- Creative techniques such as Brainstorming, Mind Maps (Buzan, 2000), Analogies, etc. are applied to obtain new ideas for solutions. Students are often amazed by their own ideas.
- In this atmosphere of creativity, the first thoughts that come to mind are expressed without further analysis. Even nonsensical ideas must be duly respected at this point.
- Attention time in creative periods should be limited because these are high energy consumers. After a period of great attention or intense mental work, the brain needs to rest. Specifically, a break is scheduled in the middle of four-hour classes and, after working on a topic, a fun moment lasting between 2 and 4 minutes is provided to lighten up the work atmosphere and relax the mind, which will then be better prepared to grasp and apply new explanations.
- It has been demonstrated that students are more creative when working in a relaxed atmosphere, and humour is known to be an effective tool to hold attention and relieve stress. Creative moments, whose occurrence produces a rush of pleasure, are often associated with fun times.

Analysis of ideas:

- The first solutions proposed are questioned to create an atmosphere of search for alternatives. This strategy encourages the appearance of more creative solutions.
- Whether an exercise is done during class time or at home, it is always interesting to briefly discuss all the solutions in the classroom, making sure that due respect is given to all of them.

Recognition:

- Individuals and student groups who excel in their work must be duly recognised to increase self-esteem or create a sense of belonging to an interesting group. The lecturer's recognition of their work, contributions or merits is highly motivating for students.

The above factors and actions can be used to reflect about the environment and motivation techniques required to improve student creativity. The following section presents the results of two student surveys on the enhancement of student creativity.

4. Student surveys

Two anonymous surveys on creative environments and motivation were conducted during the 2011-12 academic year to know the students' opinions. Some of the questions derived from the above list of environmental conditions and actions.

The surveys were given in two courses with creativity as one of their main objectives, i.e. *Creativity, Ecodesign and Patents* (CEP) and *Creativity Management and Product Innovation* (CMPI).

Both courses are the evolution of previous courses. CEP has its roots in the course entitled *Innovation and Patents* (first edition during academic year 1996-97), with fifteen editions and a total number of students of 369 (the average number of students per course was about 25). CMPI is the continuation

of the course entitled *Creative Phase in the Product or Service Innovation* (first edition during academic year 1996-97), with sixteen editions. Until now the total of number of students has been 167, including some PhD students, and the annual average number of students was 10.4. Since 1996-97, the total number of students enrolled in both courses has been 536.

4.1 Results

A survey was conducted among students at the end of the CEP and CMPI courses, with 23 and 10 answers collected, respectively. All questions were rated on a 5-point scale, ranging from 1 (strongly disagree) (No) to 5 (strongly agree) (Yes), with (3) meaning indifference point. The numbers in the tables are the total number of responses for each score. The last column contains the average score (A), which is considered an approximation of the results, which only show a trend. Tables 1 and 3 are contain the results for the CEP course while Tables 2, 4, 5 and 6 are the results for the CMPI course.

The questions about motivation to work (Table 1) are related to the final purpose of the exercise. The possibility to become an actual solution to a problem was highly rated (4.7). However, the items “become an actual patent” and “be manufactured and marketed” were slightly less motivating (3.9).

Table 1. Questions about student motivation and the design (CEP)

Degree of agreement	No		Ind		Yes	
Is a motivation for you to find ideas which could	1	2	3	4	5	A
Solve a problem?			1	6	16	4.7
Become an actual patent?		3	6	4	10	3.9
Be manufactured and marketed?		3	6	5	9	3.9

CMPI students were asked the same questions (Table 2) and the scores were similar: the items “solve a problem” and “be manufactured and marketed” were highly rated, i.e. (4.8) and (4.3). However, the item “become an actual patent” had a low score (3.1), close to the indifference point.

Table 2. Questions about student motivation and the design (CMPI)

Is a motivation for you to find ideas which could	1	2	3	4	5	A
Solve a problem?				1	7	4.8
Become an actual patent?	2	1	2	2	1	3.1
Be manufactured and marketed?			1	4	3	4.3

Other questions related to group work are shown in Table 3. The first question concerns the choice of work topic by themselves or by the lecturer. The score reveals that students (CEP) clearly prefer to choose their own topics. As for the number of group members, five seems to be the preferred choice. Finally, students were quite satisfied with the overall quality of the course.

As with the first question in Table 3 (“Would you have wanted the lecturer to choose the topic?”), the response to item 3 in Table 5 “I prefer the lecturer to select the topic of work” showed that CMPI students also preferred to choose their own topics.

Table 3. Questions about group work (CEP)

About work:	1	2	3	4	5	A
Would you have wanted the lecturer to choose the topic?	16	5	1		1	1.5
Would you have wanted to work in a smaller group?	9	6	4	3	1	2.2
Are you satisfied with the overall quality of the course?		1	2	12	8	4.2

Table 4 contains questions about the importance of the classroom environment to create the right atmosphere for creativity. The responses to these questions clearly show a strong agreement (4.3) on

the adequate environmental conditions of temperature, light and noise, including the need for movable tables and chairs to support team-work learning.

A relaxed atmosphere also implies clear, concise, attention-grabbing teaching, with breaks for rest and moments of humour to lighten up the atmosphere.

Table 4. Questions about the creative environment (CMPI)

Importance of having a creative environment in the classroom	1	2	3	4	5	A
Relaxed atmosphere			3	1	6	4.3
Moments of humour			3	1	6	4.3
Appropriate environmental conditions (infrastructure, etc.)			2	3	5	4.3

Items about student preferences are shown in Table 5. A score of 4.2 was given to the item “I prefer to discuss the ideas for solutions obtained”, which means that students want the ideas about a problem of invention produced by the groups to be discussed among the whole class.

The item “I prefer to work in groups” was rated 4.3; that is, most students prefer group to individual work.

A slightly higher score than the indifference point (3.3) was given to the item “I prefer ideas to be recognized (individual or group)” because the winning idea is produced by a single person, even if working within a group.

Students disagree (2.4) with the items “I prefer the lecturer to create my group” and “I prefer the lecturer to select the topic of work (2.6), see first item Table 3.

Table 5. Items about preferences (CMPI)

Preferences for the creative environment in the classroom	1	2	3	4	5	A
I prefer to work in groups	1			3	6	4.3
I prefer my group to be created by the lecturer	3	4	1		2	2.4
I prefer the lecturer to select the topics of work	2	2	4	2		2.6
I prefer to discuss the ideas for solutions obtained				3	6	4.2
I prefer the ideas to be recognized (individual or group)		1	5	2	2	3.3

Table 6 contains items about personal preferences for creative activity. Two items, i.e. “I like creating within a group” and “I prefer to create within a group” have a relatively good agreement (3.9). But the item “I like to create individually (3.3) is close to the indifference point. On the other hand, the item “I prefer to create with creative software (computer)” is poorly rated (1.9).

Table 6. Items about the creative activity (CMPI)

In my creative activity (ideas),	1	2	3	4	5	A
I like to create individually		3	3	2	2	3.3
I like to create within a group	1		2	3	4	3.9
I prefer to create within a group	1		2	3	4	3.9
I prefer to create with creative software (computer)	4	3	3			1.9

The next section discusses the survey results, which correlate with some of the actions to enhance creativity based on the lecturer’s experience (section 3), and draws some conclusions.

5. Discussion and conclusions

It is assumed that the basic motivation for students is the desire to learn and obtain a degree that increases their chances in the labour market. Since creativity is nowadays an asset for design engineers, higher education curricula should include the training of this skill.

This paper explains about how to improve the creative abilities of students based on the author's experience gained over time through teaching two courses, i.e. *Creativity, Ecodesign and Patents* (CEP) for undergraduate students, and *Creativity Management and Product Innovation* (CMPI) for graduate students. Other lecturers or professionals may have similar or other strategies.

The number of survey responses was not high, but indicated trends in the students' opinions, which were basically in agreement with the actions derived from the author's experience.

Figure 1 represents the individual characteristics of a student surrounded with environmental conditions that can affect creativity, and some classroom actions to enhance their creativity.

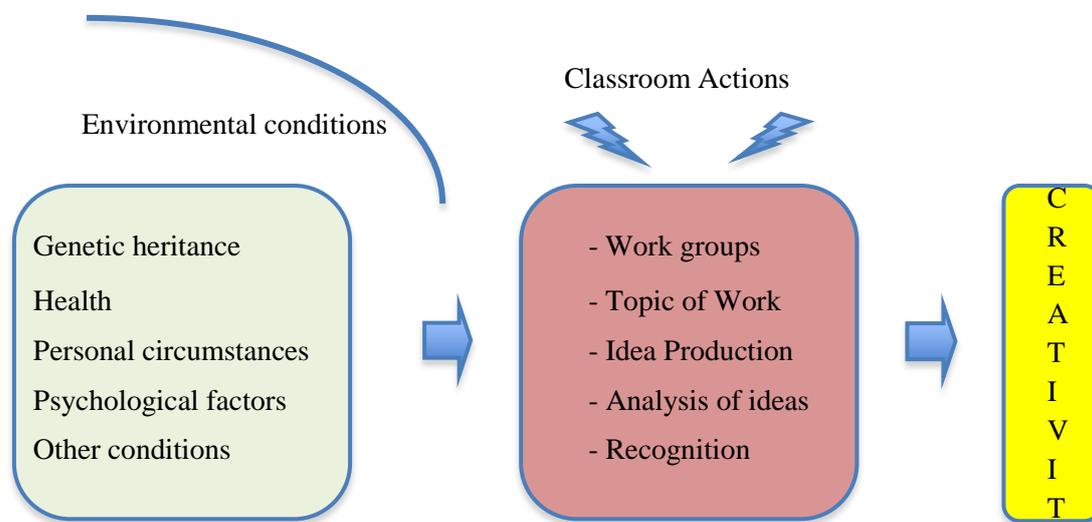


Figure 1. Factors and actions related with creativity

The main points of action in the creative environment described in section 3 are correlated with the tables of the survey results (section 4.1) and summarized below:

- Acceptable environmental conditions. They are corroborated by the surveys (see Table 4).
- Creation of work groups by students (see Table 5).
- Group work (see Tables 5 and 6).
- Interesting, innovative topics.
- Simple topics.
- Specific topics chosen by students (see Tables 3 and 5).
- Desire to design an actual product (see Tables 1 and 2).
- Use of creative techniques.
- Respect for student opinions and ideas.
- Limited time of mental work.
- Relaxed atmosphere (see Table 4).
- Questioning of first ideas for solution.
- Discussion of ideas for solutions proposed (see Table 5).
- Recognition of good ideas (see Table 5).

Moreover, students generally appreciate an unnoticed environment and a relaxed atmosphere. They prefer to work in groups, and it is so that products designed by groups are more complete than individual designs.

Students have a strong sense of initiative and want to create their group and choose their own work topic. They also claim respect for their ideas, which they like to expose and discuss, and appreciate the recognition of the best ones. Also, they would like their ideas to become a product that solves an actual problem.

The lecturer must not only teach concepts and know the problem and some of its solutions, but also become familiar with some characteristics of the students to drive their motivation. It is also necessary to manage the work topics, use techniques to elicit innovative solutions from students and encourage questioning in order to obtain new creative ideas. Moreover, the lecture must possess the ability to understand the students' reactions and analyse their opinions through surveys at the end of the course.

One of the two surveys presented here was given to CMPI students. This was the first time that the survey included the above items, which are closely related to the actions in section 3. These recommendations of actions are often the result of trial and error. In this sense, the Institute of Education Sciences (ICE, 2012) in the Technical University of Catalonia (UPC) is responsible for the improvement of lecturers' pedagogical methods and introduction of innovative teaching strategies.

It is worth mentioning that the above teaching proposals could probably be used in other cultures to enhance student creativity, although different actions might be required.

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