Improving Creative Ability as the Main Focus to Promote Education in Architectural Design
University of Damascus as a case study

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ABSTRACT

Creativity is essential to the educational process, especially in creative field like architecture where it is useful to employ methods to aid the development of the student's creative capacities. Examples of creative development strategies used by some leading architectural design institutes are discussed in detail against which the teaching models at the architecture school at Damascus University, in Syria, is analysed. Consequently, we have found that creativity can be taught and developed through the use of certain exercises and directed methods.

INTRODUCTION

The intent of education is not only to acquire new knowledge and a broader range of skills, but it is also to achieve a comprehensive profound change in the students' behaviour and to utilise their potential energy by them with the necessary tools and methods to develop their creative abilities. The main aim of this research is to decipher the importance of concentrating on creative methods and strategies in teaching architectural design relying on teach how to think creatively in order to develop mental abilities and produce creative solutions for design problems. To keep up with the recent developments in the architectural education field, the architectural design curriculum at the University of Damascus reworked its teaching model to support creative thinking. This study is divided into four main parts. The first three parts discuss creative principles and their relationship to thinking patterns and the educational process in architectural schools, including the role of tutors in the creative education process. The last part is dedicated to the analytical study of teaching methods used in the architecture department at the University of Damascus, which is then assessed against international education experiences and methods.

THE CREATIVE AND THE EDUCATIONAL PROCESS IN ARCHITECTURAL DESIGN

Ellis Paul Torrance [1] believes that creativity trains students to fill the missing gaps. He also argues that at the core of the educational process is the presence of a problem needing asolution (Huwaidi,

FIGURE 1:
Linking the
creative process
with creative
outcomes
(Sullivan, 2013)

2007). Charles H. Sullivan [2] affirms that the primary mission of a tutor is to help students to develop their creative abilities and to enrich their imagination by encouraging them to see things from different perspective (Sullivan, 2013). Thus, to guide each student to create his own vision and to find inspiration without any restrictive conditions in order to solve design problems, freehand drawing can be encouraged to discover the beauty and charm of a design. The complexity of the architectural design process makes it a worthy topic for researchers interested in the role of intuition (Lawson, 1980) in thegeneration of architectural concepts (Mustafa, 1994).

Sternberg's theories [3] showed that the human's capability to analyse, make judgments, criticise and so forth, cannot be revealed by IQ tests, but must instead be tested through assignments that involve the generation of new ideas. The creative ability of a designer has been defined as a natural ability to employ intellectual and intuitive abilities to create a distinctive work of design (Edilbi, 2014).

CREATIVE THINKING IN ARCHITECTURAL DESIGN

De Bono defines thinking as the exploration of something in order to gain an understanding, make a decision, plan, solve a problem or to make judgment. Thus, the human mind performs five main tasks and functions: description, interpretation, reporting, planning, and implementation. These functions need time to develop and are significantly associated with training, skills and experience.

It is difficult to identify an absolute categorisation of human's thinking patterns (Ghoneim, 2002) as there is an antithesis in style for each thinking pattern. Thus, thinking patterns can be categorised in pairs (e.g. single thinking and compound thinking, mutual thinking and separated thinking, logical thinking and imaginative thinking, deductive thinking and intuitive thinking, sensational thinking and abstract thinking, or creative thinking and critical thinking) (Khalifah, 2000); by knowing these pairs, teachers can easily identify the thinking pattern of their students.
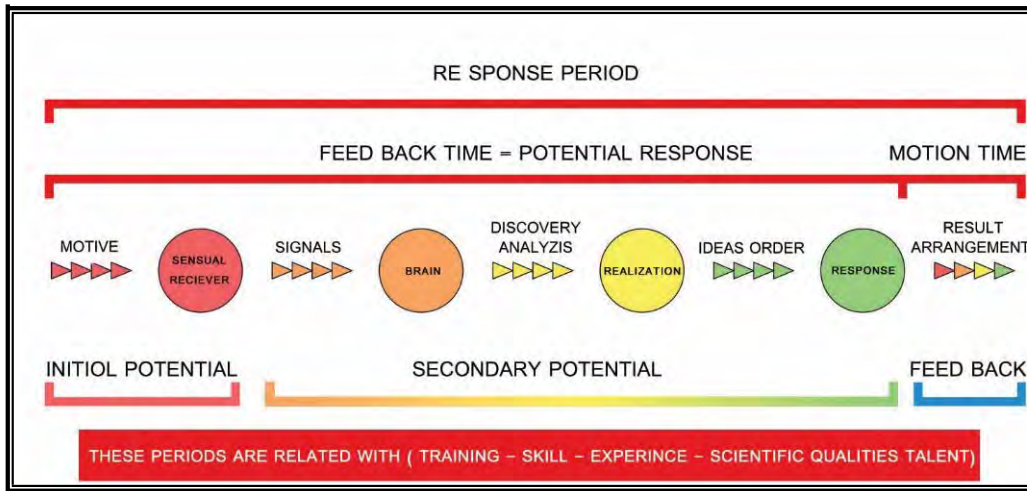
**FIGURE 2:
The relationship
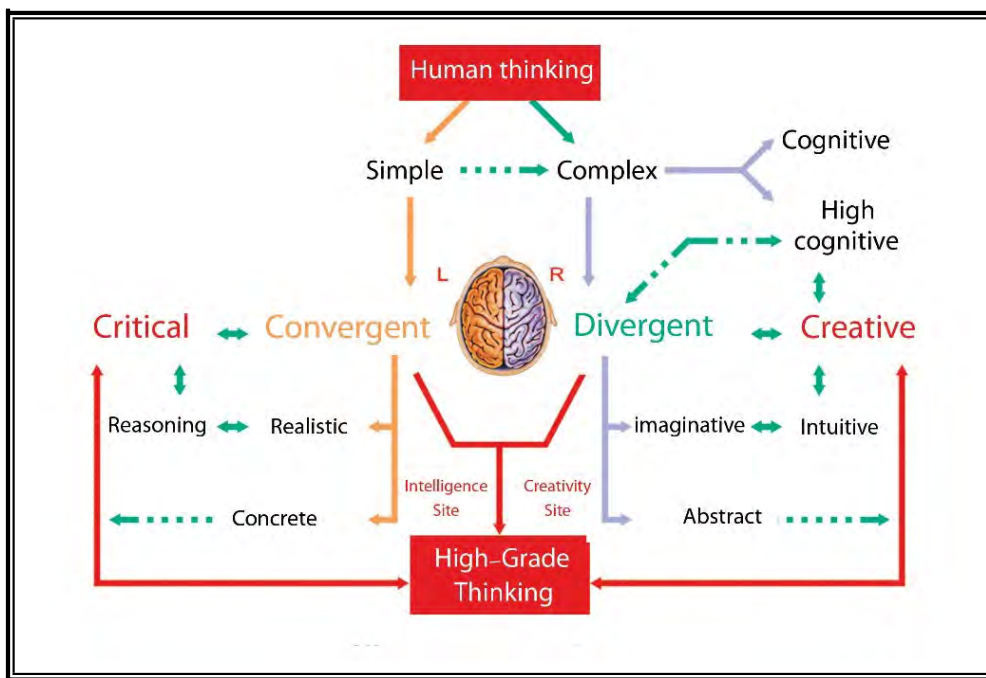between response
and time (Author)**

**FIGURE 3:
Thinking patterns
related to
architectural
design process
(Author)**

**CREATIVE THINKING + CRITICAL THINKING → HIGH-RANKED
THINKING** (Source: Arab British Academy)

Smith (2012) [4] established fan educational model that depends on
motivating the right half and the left half of the human brain to work
simultaneously to create what he calls high-ranked thinking. High-
ranked thinking is based around characteristics of fluency, flexibility and
originality creative thinking.

The importance of creative teaching in architectural design comes from
the fact that architectural design consists of two basic aspects: creativity
in design thinking and creativity in technical thought (Rafat, 1997).
Prospective students of architecture must have artistic talent,
imagination and drawing skills. Some students need intellectual training
while others need improve their skillset. The design studios reveal a

student's ability to deal with design issues and to develop their solution into a visual and functional form (Abu Saada, 2003) [5]. Creative teaching competencies can be classified into four themes; the teacher in architectural design should have a competence to teach design, teach how to think creatively (identify the thinking pattern and choose suitable teaching method accordingly (Shehata, 1998)), discover the students' talents and to develop their potential skills.

De Bono argued that in order to teach students to think creatively, a tutor (or sponsor) trained to discover the creative abilities of individuals is required.

FIGURE 4:
Utilizing talent, skills and teaching in the thinking process to achieve creative outcomes (Author)
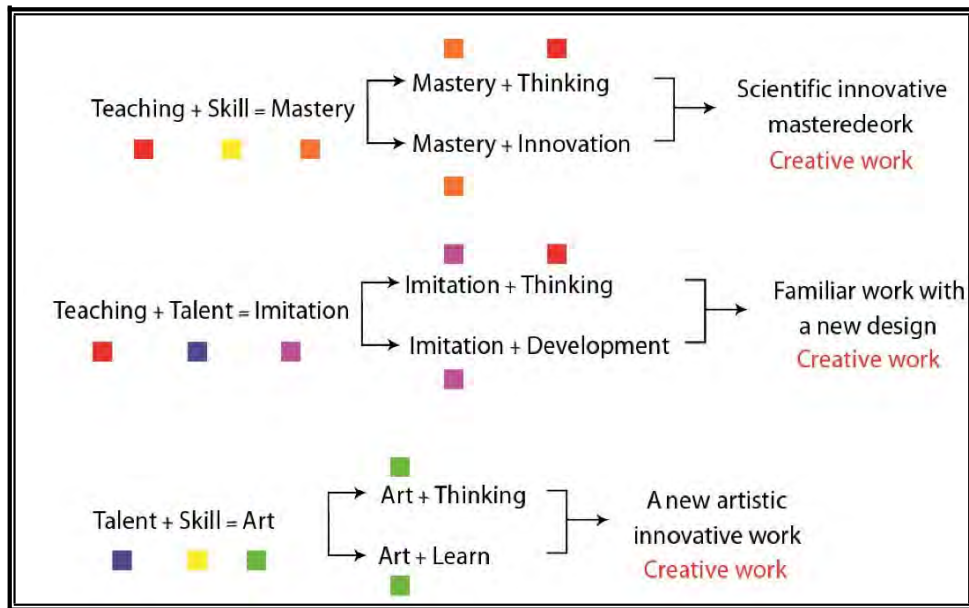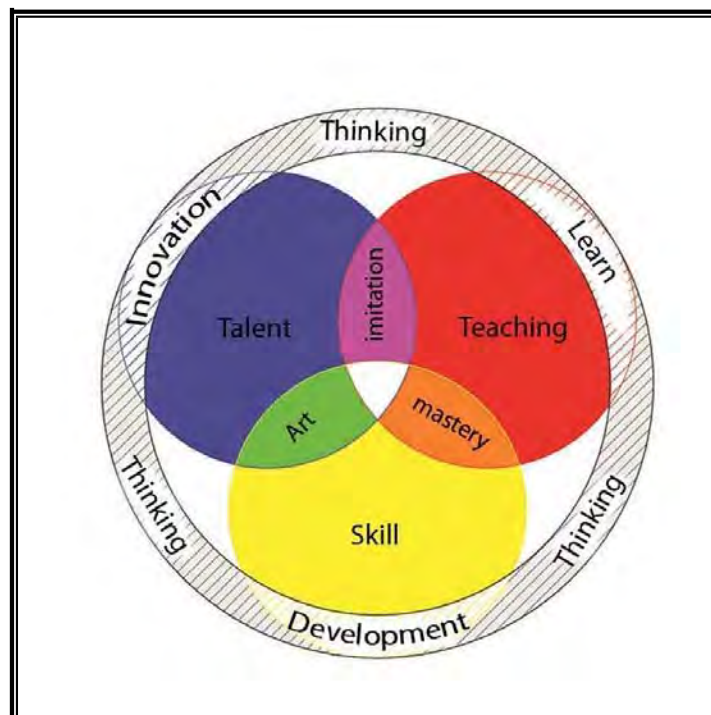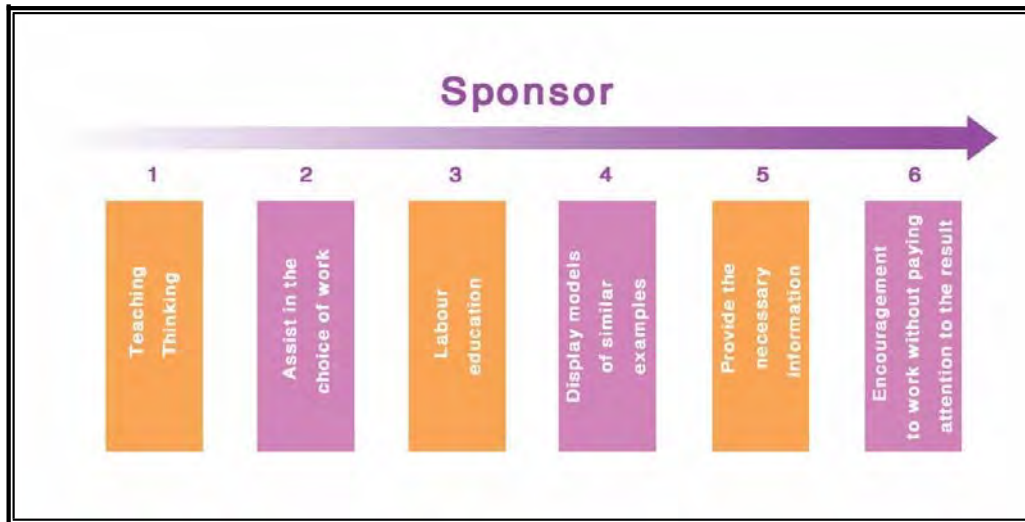

FIGURE 5:
Creative teaching (Author)

After twenty years of study in the field of creativity, Torrance confirmed that a qualified tutor helps his students to develop their ideas. Creative competency has been linked to tutors' skill to motivate students to simultaneously use the right half of their brain (creative thinking) and the left half (critical thinking) to develop high–ranked thinking. Some exemplar international experiments on how to teach creative thinking have been conducted by Doris [6], Johannes [7] (Johannes, 2013), Vidal [8] (Vidal, 2009), and AL-Qarni [9] (Al-Qarni, 2012). The diversity in these studies and the author's correspondence with design department in some of these international universities helped list 19 methods used to teach creative thinking. Based on this method, a questionnaire has been conducted at Damascus University and the outcomes of this questionnaire have been compared with design teaching method in international universities, Table (1), in the United States, Germany, Turkey, India, Denmark and Brazil. The concluded methods are explained in more details in the following section.

University	Country	International rank
Istanbul technical university	Turkey	550
Duisburg Essen University	Germany	400
University Campinas	Brazil	300
Yildiz Technical University	Turkey	1300
Technical University of Denmark	Denmark	150
BKPS	India	720
Illinois	U.S.A	107

TABLE 1:
The universities contacted with their respective international ranking

The *first method* is based on "Breaking Hypotheses" and is composed of three stages (Kowaltowski et al., 2010). The first stage is to make a list of assumptions about the design problem(s). The second stage is to choose the most important hypothesis that solves these problems. The third stage is to test the validity of these solutions.

The *second method* consists of seven stages and is based on the identification of difficult problems a designer encounters (Kowaltowski et al., 2010). The seven steps consist of collecting the data, displaying the theoretical information, evaluating the problem, comparing case study problems with problems from reality, expressing the desired modifications, solving the problem and then improving the process.

The *third method* relates to cause and effect (Kowaltowski et al., 2010). In this method, the design idea cannot be identified without explaining the reason or the cause for it, where only logical solutions are accepted.

The *fourth method* emphasises the use of brainstorming (Al-Qarni, 2012). According to Osborn, an "Innovative Meeting" is sort of group discussion that lead to generate a list of ideas and creative solutions for specific design problems. The principles of this method are to encourage the acceptance of unfamiliar ideas, to avoid criticism and quick judgement of the presented ideas, to establish free thoughts and to accumulate the largest number of ideas without considering their quality in order to develop them later based on other ideas.

The *fifth method*, called mini Delphi (Kowaltowski et al., 2010), is an organized communicating technology, originally created as a forecasting systematic method. It is based on a group of architectural design experts (teachers or students) and is used to study the intersections of the brainstorming method through the convergence of solutions. Afterward, the best solution is chosen by applying the brainstorming method again.

BRAINSTORMING → DELPHI → BRAINSTORMING

The *sixth method* is a field analysis force (Kowaltowski et al., 2010). This method is based on the principle that any case has its advantages and disadvantages. The main goal is to reach a solution that has more advantages than disadvantages. Doris has employed this concept in the analysis of existed buildings through in situ investigation of the facades congruency, colour choices and building and cladding materials. Also, she used the same method to analyse the idea behind the landscape of the studied buildings. After that, grades were specified according to a developed proposal that promotes the quality of each case.

The *seventh method* involves creating a gallery space where practitioners with design and technical experience in the architectural practices can meet to both discuss and contemplate. Unusual materials like "soap, wax and candy" would be on-hand to encourage creative exploration and representation of ideas.

The *eighth method*, the so-called the Unleash concept (Kowaltowski et al., 2010) includes the possibility of having quarterly projects or integrated projects that would contain imaginative and unconventional ideas.

The *ninth method* relates to the input and output of data (Kowaltowski et al., 2010). The intent of this method is to study the data, specify the target, and then reach the goal in an unusual way with guaranteed construction capability regardless the cost and duration of implementation.

The *tenth method* is referred to as NAF (Novelty, Attractiveness and Functionality) (Kowaltowski et al., 2010). This method is based on dividing the project in relation to the three specific aspects: novelty, attractiveness and functionality. This can be useful to evaluate the design performance independently through specifying certain levels and grades (1-10).

The *eleventh method* makes use of Mind Maps (Vidal, 2009). A Mind Map is a type of graphic that combines languages, words, and logical operations with creative imagery. A Mind Map is used to generate a number of ideas that contribute to the development of creative thinking. This method is not used by any university so far.

The *twelfth method* is known as QDF (Quality, Design and Functions) (Kowaltowski et al., 2010). In this method, the functions of a project are converted into design elements in order to increase the quality and aesthetics of the work. The basic element, which leads to success in this method, is considered to be the perfect result of analytical charts and Mind Maps.

The *thirteenth method* is called Morphological Analysis (Kowaltowski et al., 2010). Morphological analysis is a technology that provides solutions for problems using well structured systems and through simplifying the problems. Mind Map is used to exclude all illogical solutions.

The *fourteenth method* is based on the harmony of separate ideas. This strategy involves making relationships between various items that have not previously been used in combination to solve a specific problem. This strategy defines the strange as familiar and the familiar as strange.

The *fifteenth method* is related to developing the other point of view. This method is used to strengthen the students' creative personality and to develop their arguing skills. By discussing problems and supporting unfamiliar solutions, the tutor aims to help students turn negative results into positive ones.

The *sixteenth method* is about discussing alternatives and solutions (Kowaltowski et al., 2010). This method requires a qualified active tutor to select students randomly in order to provoke spontaneous potential ideas.

RANDOM SELECTION + RANDOM THOUGHTS + IDEAS MODIFICATION + APPLYING NEW IDEAS + REARRANGING AND FORMULATING = EXPLORING NEW CREATIVE IDEAS.

The *seventeenth method* uses what is called paper storming (Al-Qarni, 2012). Firstly, students are distributed into groups in which each group contains different levels of thought patterns. Secondly, the students' projects are exchanged consecutively within the same group and each student is asked to identify the positive and the negative points of the project on the same sheet. To have a project criticized and discussed by all members of the group provides a substantial opportunity to acquire new experience.

The *eighteenth method* is CPS (Creative Problem Solving) (Vidal, 2009). This method teaches students about creative thinking patterns and criticism and aims to develop students' high-ranked thinking abilities. The CPS method is also based on some concepts (e.g. modification, photography, experimentation and exploration) that promote and stimulate creativity.

The *nineteenth method* is called MADE "Model for Architectural Design Education" (Johannes, 2013). Using this method, students are left with a new project brief for a period of time, usually one or two weeks, and are asked to think independently and develop their own creative solution. Then, the students are divided into groups to discuss their achievement and determine the advantages and disadvantages of each work. In this stage, experienced architects and engineers should supervise the students. Eventually, each student will continue to work on his own, while working in teams. The objective of this method is to provide students with the desired experience through self-learning rather than through teaching.

To conclude, the sue of the previous methods in the educational process serve to develop the students' creative abilities to identify and analyse design problems, to find alternative solutions, to develop distinctive ideas, to check the quality of their ideas, to present the final design ideas in drawings and models and to produce a creative design product.

The qualities of the nineteen methods for teaching creative thinking in design are analysed in Table 2. For example, the first method (Breaking Hypothesis) has been shown to help students to identify and analyse problems by teaching them to critically evaluate the problems and solutions. It also helps students to find alternative solutions without sacrificing the quality.

Some comparative *teaching how to think methods* used by a selection of international universities is presented in Table 3 and Figure 7.

Figure 7 shows that the best use of educational thinking methods in design is at Duisburg Essen University, which is globally ranked as (400). On the other hand, the Technical University of Denmark has the lowest global ranking at (150), though it has been shown to make a

METHODS																			
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	
BREAKING THE HYPOTHESIS	THE SEVEN STAGES	CAUSE AND EFFECT	BRAINSTORMING	MINI DELPHI	FIELD ANALYSIS	CREATING A GALLERY FOR	UNLEASH	INPUT AND OUTPUT	NaF	THE MENTAL MAPS	QDF	THE MORPHOLOGIC	THE HARMONY OF SEPARATED	DEVELOPING THE OTHERS'	ALTERNATIVES AND	PAPER STORMING	CPS	MADE	
+	+		+	+	+	+	+	+	+		+	+	+	+	+	+		+	IDENTIFYING AND ANALYZING THE PROBLEM
+	+	+			+	+	+	+	+	+	+	+	+				+		SELECTING AND DEVELOPING IDEAS
		+			+	+	+	+			+		+	+		+	+	+	FINDING ALTERNATIVE SOLUTIONS REGARDLESS TO QUALITY
+		+	+	+	+	+	+	+	+	+	+	+	+	+		+	+	+	INVESTIGATING IDEAS' QUALITY
	+		+	+	+	+	+	+	+	+	+		+	+	+	+	+	+	STRUCTURING IDEAS
+	+		+	+		+	+			+			+		+				WORKING INDIVIDUALLY
+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	WORKING IN GROUP

TABLE 2: Configuring methods in the education of thinking

small effort to use *teaching how to think methods* during the design process.

TEACHING METHODS USED IN THE ARCHITECTURE DEPARTMENT, UNIVERSITY OF DAMASCUS: ANALYTICAL STUDY

Using a questionnaire to collect data about the lecturers and students of the architectural department in Damascus University, an analytical study has been conducted to identify their role in developing creative abilities in teaching how to think creatively. Each questionnaire was divided into several sections using closed questions according to Likert's triple measure [10] where participants were required to choose between three answers: yes, not applicable and no. The responses and results were then analysed using SPSS software.

The lecturers' questionnaire consisted of five sections and the students' questionnaire consisted of four sections. Each section was found to be very helpful in revealing some missing gaps in the creative design development process.

The first section questioned their personal opinion of academic staff excellence, with questions such as, 'Do you consider the academic staff of the design classes to be distinctive in comparison with respect, to Arab/international universities?' The survey found that the academic staff in architectural design is not entirely convinced that the teaching talent at Damascus University compared favourably to international

TABLE 3: The percentage of using thinking education by universities in general

Universities	International rank 2014	BREAKING THE HYPOTHESIS	THE SEVEN STAGES	CAUSE AND EFFECT	BRAINSTORMING	MINI DELPHI	FELD ANALYSIS FORCE	CREATING A GALLERY FOR THE PRIVATE IDEAS	UNLEASH	INPUT AND OUTPUT	NAF	THE MENTAL MAPS	QDF	THE MORPHOLOGICAL ANALYSIS	THE HARMONY OF SEPARATED IDEAS	DEVELOPING THE OTHERS' POINTS OF VIEWS	ALTERNATIVES AND SOLUTIONS	PAPER STORMING	CPS	MADE	Percentage of using Thinking education %
Istanbul	550	+						+	+				+			+			+	+	37 %
Essen	400	+		+	+	+	+		+	+	+			+		+				+	58 %
Campinas	300						+		+				+		+	+	+	+	+		37 %
Yildiz	1300	+	+				+	+	+	+						+	+		+	+	53 %
Denmark	150						+			+	+		+	+					+		37 %
BKPS	720	+	+	+	+					+	+				+			+			37 %
Illinois	107	+	+	+			+	+			+							+	+		48 %

FIGURE 7: The percentage of using methods to teach thinking by different international universities
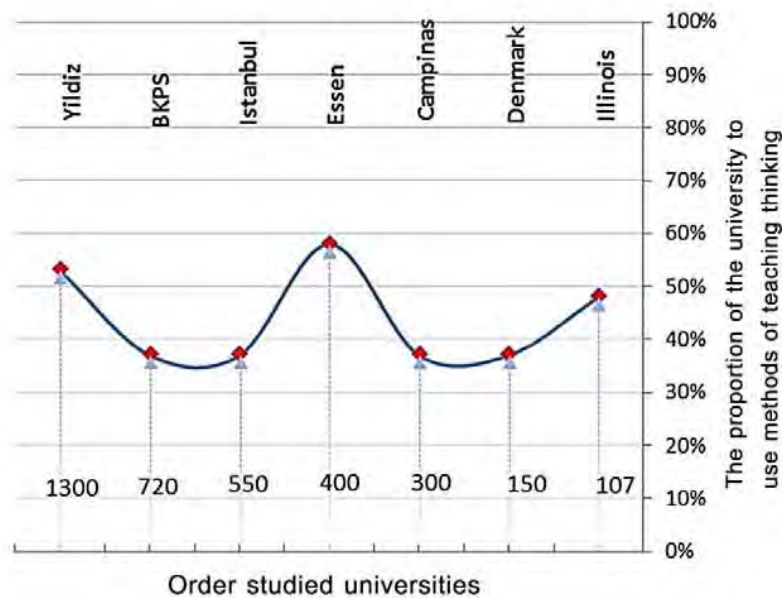
universities. Conversely, architectural students seemed to be very confident in their personal creative abilities regarding design studios classes.

The second section surveyed the participants' interest in self-developing. For example, in the questionnaire for lecturers, one question asked, 'Have you attended any course for teaching creative methods in architectural design? If not, are you interested in pursuing architectural design teaching techniques of Arab and international world?' in the student questionnaire, one question asked, 'Do you contribute in putting creative touches on your colleagues' projects?' The academic staff at Damascus University showed a significant interest in self experience development in the field of teaching architectural design module. A full 60 per cent of the academic staff had expressed willingness to attend qualified workshops of creative teaching methods,

while students acted positively towards involving creative aspects in design.

The third section was written to decipher teaching methods used by the academic staff in architectural design. This section asked questions like, 'Do you motivate the students to submit their projects in an innovative way, using renderings, physical models and other medium?', 'Do you give your students the opportunity to express their creative ideas even if they were wrong?', 'Do the occasional critiques in front of their studio classmates make students more eager to achieve excellence?', 'Do you support their idea of presenting and discussing their projects through social media?'. The academic staff at the University of Damascus were found to pursue methods of global architectural design education and to follow some teaching strategies; however, students were not convinced that the quarterly projects grades accurately reflect the level of their creative abilities in the design class.

The fourth section inquired about the academic staff's interest in developing the students' creative abilities. Examples of questions in this section were, 'Do you think that students' use of computers during studio critiques support their creative side?', 'Do you support the idea of honouring the qualified professor and the creative student in a similar fashion to some Arab and international universities?', 'Do you think that the development of students' creative skills is the responsibility of the academic staff?'. The academic staff members have shown interest in developing the creative abilities of architecture students and students were shown to support the development of personal creative abilities through workshops and training courses offered by the architectural department.

The fifth and final section asked lecturers about the students' grades and whether they are related to their level of creative ability, suing questions like, 'Do you think that the grades of the quarterly projects and short exams are related to student's creative capabilities?' The questionnaire found that the students' grades in the design studios are an expression of their creative capabilities.

This study has found that some developing methods and strategies for teaching creative thinking in Damascus University are similar to the educational curriculum or training workshops of other international universities. This finding has motivated a majority of the academic staff at Damascus University who had not had any related course before to give a massive attention to solve this missing gap in the educational system. This study was supported by two workshops held at Damascus University. The first was a 25-hour training workshop for architectural students at Damascus University, called *Teaching How to Think Creatively in Design by Using Some Mental Abilities Development methods*, was held over five days and was attended by 35 students. Based on the principle of having 35% of excellent, 35% of average, and 35% below average, 14 students from the fourth year and 21 students from the third year in architectural design were distributed into seven groups. The workshop consisted of three stages. The first stage

contained eight exercises to evaluate the students' creative abilities by presenting them with a problem and a large number of alternatives to be solved in a limited time.

The first exercise asked students to divide a square into three parts.

The second exercise asked students to draw alternative shapes for two lines with a triangle.

The third exercise asked students to draw a quadrilateral with a closed curved.

After these exercises were completed, each group was asked to choose the three best and three worst alternatives. This was designed to teach students to critically evaluate their own work and the work of their group members.

The fourth exercise asked students to form two lines with a closed curved line.

The participants were asked in the fifth exercise to attribute specific function to some shapes given to them and to explain the reason behind their choices.

In the sixth exercise, students were asked to critique, analyse and evaluate the shapes.

At the end, students were asked to find a relationship that links three triangles in order to form a suitable elevation of a recreational building, and then to provide it with a fancy furniture design. All of these exercises were executed with free-hand drawings only.
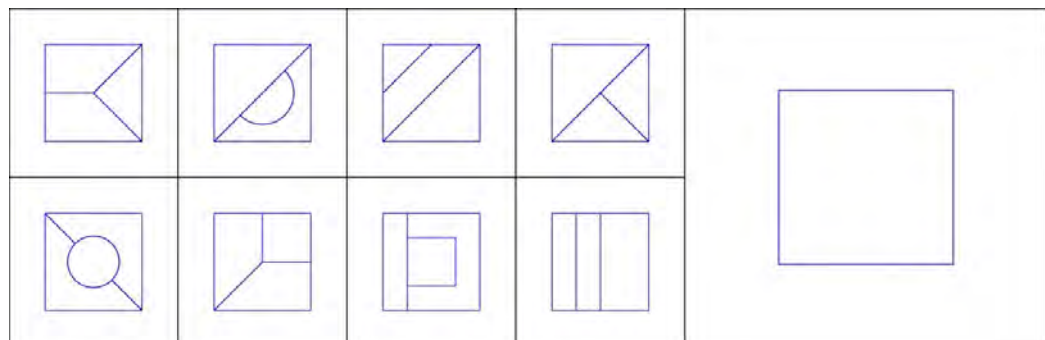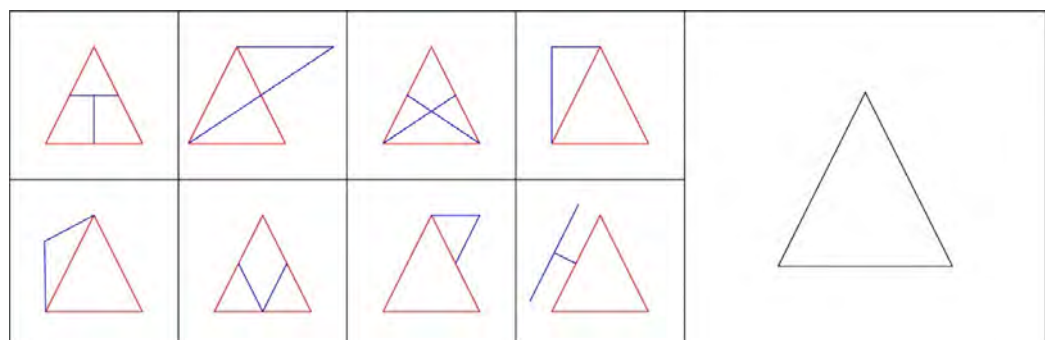
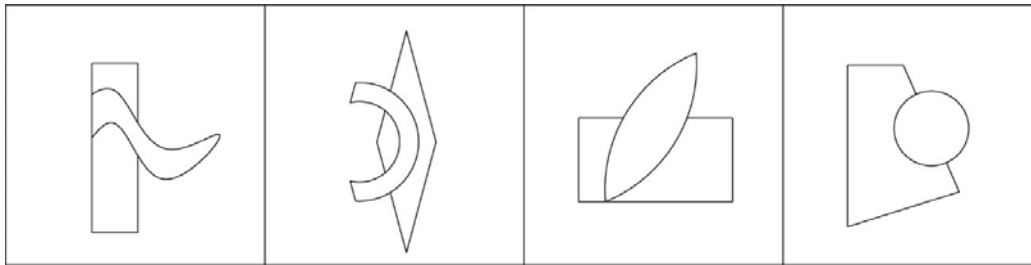**FIGURE 8: Exercise 1**

FIGURE 9: Exercise 2
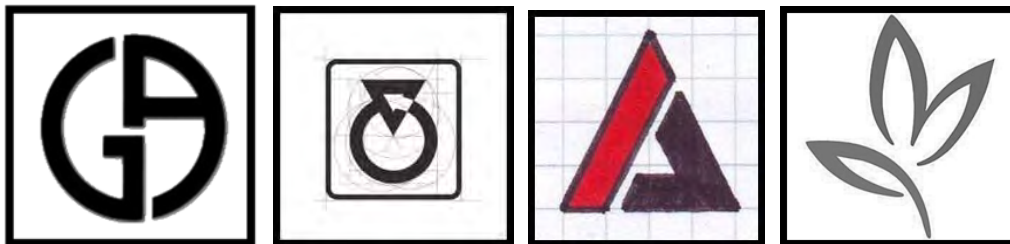
FIGURE 10:
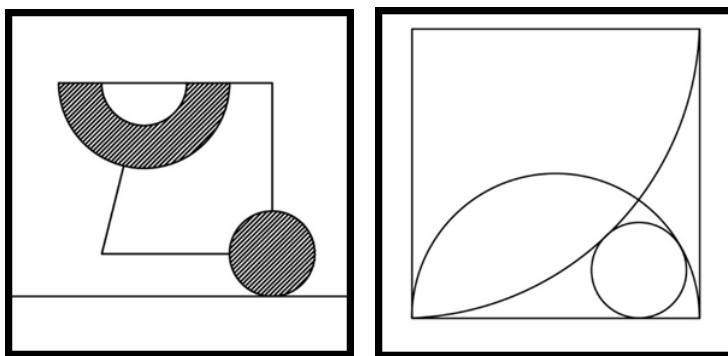**Exercise 3**

FIGURE 11:
Exercise 5

FIGURE 12:
Exercise 6

During the second stage of the student workshop, theoretical lectures were given on using basic architectural proportions and colours. The third stage used more difficult exercises mimicking some international experiments in *teaching how to think creatively methods* using Mind Maps and brainstorming. Afterward, students were given a final test to form shapes that incorporate a circle, a semi-curve and a quadrilateral (Figure 13). Students were then asked to choose the best forms (Figure 14) to design a woman bag (Figure 15) and a façade of a building's fence (Figure 16).

The second workshop was designed for 20 lecturers of the first-year design studios and for the top 15 students from the previous workshop. Workshop attendees were divided into five groups, with each group consisting of four lecturers and three students. The workshop was designed to consist of 4 stages that extend over 4 days; each stage lasted for 3 hours. Lectures on creative abilities, thoughts and strategies in architectural design were presented in the first stage. The second stage was devoted to placement exercises that used creativity exercises like brainstorming, the NAF and Mind Maps. During the third stage, lecturers were asked to submit theoretical and practical projects based on new educational methods used in *teaching how to think creatively*, and to be performed in the workshop for students. Lecturers were divided into four groups of five, and each was asked to work with

16 first-year students. Students were evenly distributed based on their academic ranking into four groups: four top students, four good students, four average students, and four below average students. In the final stage, each professor was asked to present their results from this experiment, and hopefully to collaborate with the academic staff of Damascus University to develop a course based on *teaching how to think creatively* and create a proper new handout.
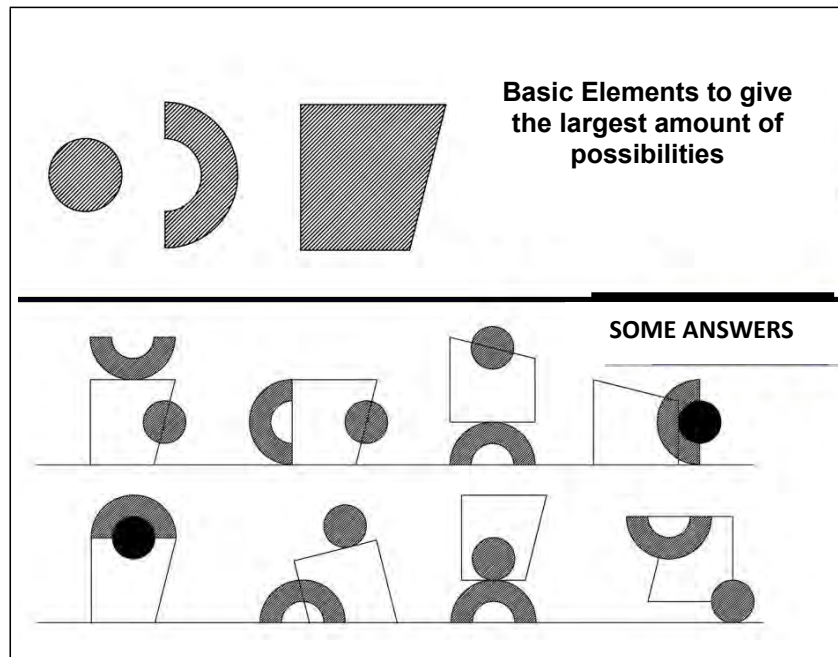
FIGURE 13: Forming Shapes

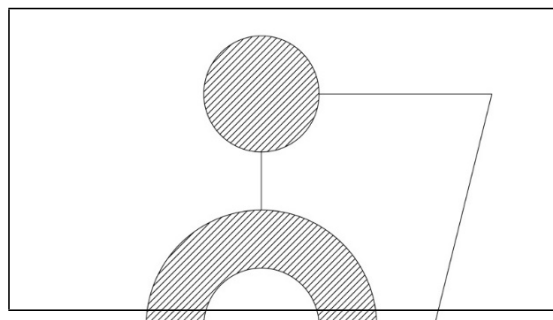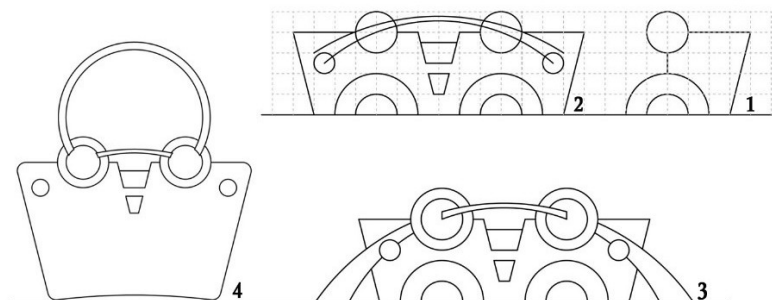**FIGURE 14: Choosing the best shape (criticise-analyse-evaluate)**

FIGURE 15: Developing the previous shape to design a woman bag Basic Elements to give the largest amount of possibilities
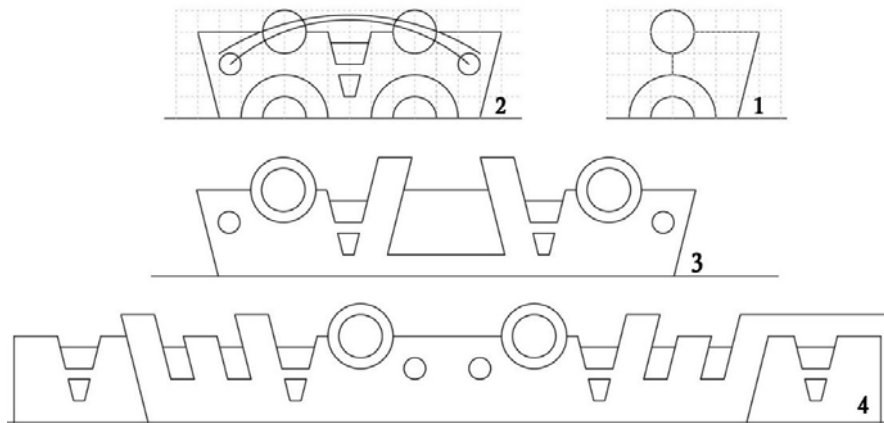
In conclusion, these two workshops trained twenty lecturers at Damascus University in *teaching how to think creatively* and helped to create an academic handout for teaching creative classes. Should these workshops be repeated, Damascus University has competent academic staff that reflects upon the competency of undergraduates' who will one day participate in rebuilding our beloved Syria after the war.

Teaching how to think creatively has been found to play an essential role in the creation of a creative product. Furthermore, the development of creative abilities requires creative teaching strategies and an ability to teach students to think in different ways (individually, partial collaborative and full collaborative). Thus, the *teaching how to think creatively* programme can be taught through educational courses or workshops. Flexibility can be brought into the *teaching how to think creatively* model, and further mental capabilities can be achieved by focusing on educational exercises that support critical and creative thinking using the right and the left side of human brain simultaneously.

To raise the competency level of academic staff, formal measurement tools can be used to recognise creative students early on through collaborative teacher-student training workshops. Distinctive students, especially those who are in the first stages of their study and have creative mental abilities, should also be encouraged to publish their work in newspapers and architectural magazines.

This plan was presented in the "1st conference in architecture", held at the architecture department of Damascus University on 25 March 2015, to help determine the best methods for teaching how to think creatively, and to develop the trainees' creative abilities according to their trends and tendencies.

FIGURE 17:
The Relationship between teaching how to think creatively and creative outcome (Author)
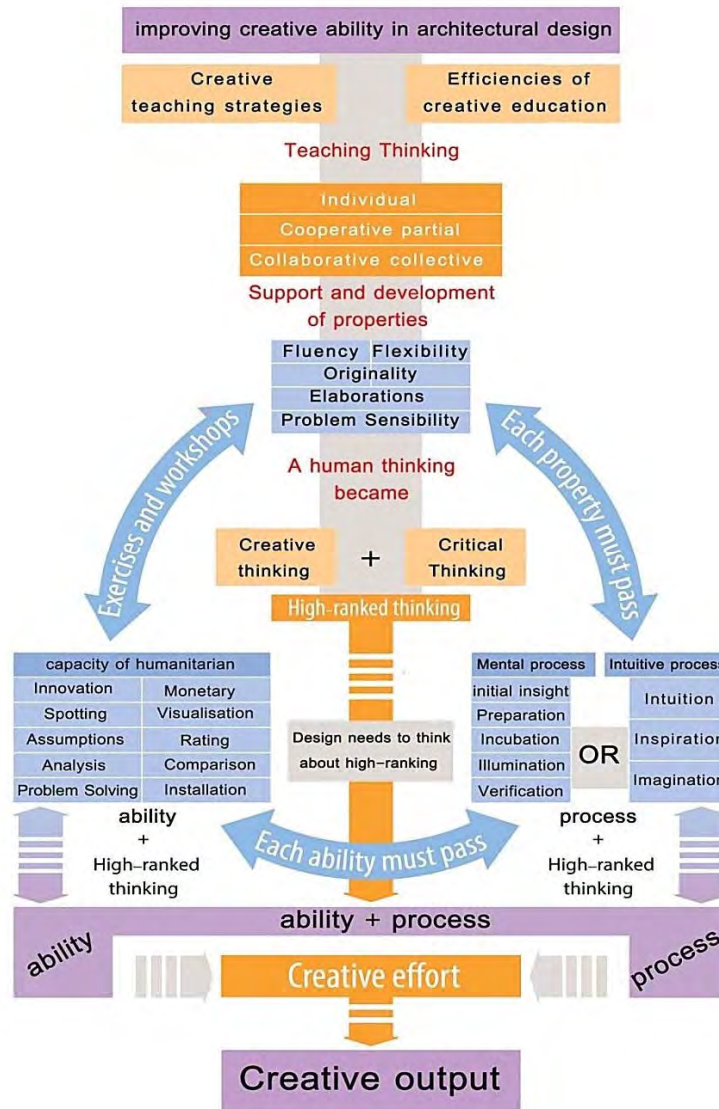
ENDNOTES

[1] Ellis Paul Torrance (1915- 2003): Professor of Educational Psychology. He is the discoverer of creative thinking scale and the founder of (Torrance Center) for developing the creative abilities. He has more than 1,000 articles and subjects specialized in creativity.

[2] Charles H. (Chip) Sullivan is a contemporary architect, professor of landscape architecture, teacher and developer of creative capabilities in design at the University of Berkeley. Sullivan.C. 2013. *"Creative Process"* [Online]. Available: http://www.gonzogardens.com/workshops/images/creative_process.pdf [Accessed 20 July 2013].

[3] Robert Sternberg (1949 m) is an American contemporary Psychiatrist holds a doctorate degree in psychology and the discoverer of psychological operations scale. He has many theories related to creativity and method of thinking, and is working as a professor at Cornell University and the University of Berkeley.

[4] Mark. A. Smith is a PhD qualified in cognitive psychology and specialized in brain training on intelligence and creative thinking.

[5] Abu Saada, H. G. 2003. *Architectural design education in view of the relationship between creativity and design processes.,* Saudi Arabia, C2. The current drawing resulted when developing the overlapping creativity triples drawing (Abu Saada, 2003)

[6] Doris C.C.K. Kowaltowski is a contemporary architect, who holds a doctorate degree in architectural design. Doris is a faculty member at the University of UNICAMP in Brazil, specialized in developing and supporting architectural design process and its methodology.

[7] Ralph Johannes (1928) is a German architect, the founder of the (Made) way. He has 40 years teaching experience in architectural design module in international universities. Johannes , R. 2013. Available: http://www.made-me.de/madeimprimatur.htm [Accessed 10 September 2013].

[8] René Vidal is a university professor and researcher in the field of creative processes and painting at the School of Visual Art

[9] Yaan Allah Qarni is a teacher at King Abdul Aziz University. He holds a PhD in math creative teaching.

[10] Likert scale: it is a method for measuring the behaviours and preferences and used in psychological tests. It is discovered by the psychologist Rensis Likert. It is used in the questionnaires of this study.

REFERENCES

Johannes, R. (2013), "Model for Architectural Design Education", available at: http://www.made-me.de/madeimprimatur.htm (accessed 1 December 2015).

Kowaltowski, D. C., Bianchi, G. & De Paiva, V. T. (2010), "Methods that may Stimulate Creativity and their use in Architectural Design Education. *International Journal of Technology and Design Education,*

Vol. 20 No. 4**,** pp. 453-476.

Lawson, B. (1980), *How Designers Think: The Design Process Demystified.* The Architectural Press, Michigan

Mustafa, A. O. M. S. (1994), *Thought of the Design Process: Abilities, Intellectual Entrances, Dominant Effects.* Master thesis, University of Cairo.

Smith, M. (2012), *Creativity and IQ, Part I: What Is Divergent Thinking? How Is It Helped by Sleep, Humor and Alcohol?,* available at: http://www.creativitypost.com/psychology/reativity_and_iq._what_is_divergent_thinking_how_is_it_helped_by_slee (accessed 1 December 2015).

Sullivan, C. (2013), *"Creative Process",* available at: http://www.gonzogardens.com/workshops/images/creative_process.pdf (accessed 1 December 2015).

Vidal, R. V. V. (2009), "Creativity for Problem Solvers". *The Journal of Human-Centred Systems and Machine Intelligence*, Vol. 23 No. 3**,** pp. 409-432.

Ghoneim, M. N. (2002), *Architectural Creativity between Systematic Thought and Spontaneity.* Ph.D thesis, University of Cairo.