

# EEG as evaluation Tool to Understand the Impact of Pull On Architecture Design Students.

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**Abstract** – Design is a very dynamic activity with respect to its process, output, person's response and its evaluation. The dynamics in design teaching is due to variation in students grasping and response. It also depends upon the pedagogical approach followed in the task. Generally the output is evaluated with respect to acquired skills in terms of drawings produced rather than the impact created by the process. The impact is mainly in design thinking process. The design thinking process is metamorphic with the influence of internal and external element. Solving all these thinking layers and reaching the final layer need a strong pull (Cognition as internal and mood boards as external). A presence of a pull factor in design gives a direction to the designer. The attempt to identify and analyze the strength of pull is highly negligible in the traditional evaluation techniques. As the evaluation happens in isolation of the output and not of the thinking process along with the output. To understand the impact of pull / inspiration in design process, objective methods of scientific measurement should be used. These issues are addressed in-depth in the doctoral research; where as this paper talks on the fundamental requirement for use of Scientific means (EEG -Electroencephalograph) to understand the impact of the pull on the architecture students. This paper elaborates the pilot study stage observations and correlates to the literature statements.

**Key Words:** Design evaluation<sup>1</sup>, Measuring Creativity<sup>2</sup>, EEG in education<sup>3</sup>.

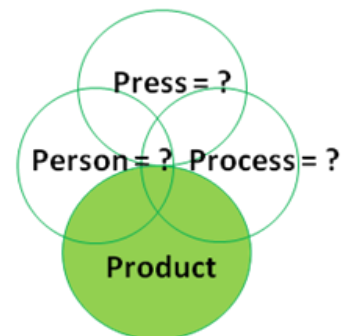
## 1.INTRODUCTION

Creativity is commonly defined as thinking out of the box or being novel. Creativity is a joint contribution of the creative process, creative person, creative product and creative press (environment or data). The simplest definition according to Kris [1957] is - 'the arousal of the brain could be related to creativity'. Evaluation of the end product in an academic situation involves assessment of the creative content of the end product and process. The personal capability to create during the process of design learning and deploying are not assessed, evaluated not recorded. Even the end product is evaluated by a teacher / facilitator thereby

increasing the chances of subjectivity and disparity. The disparities due to subjective evaluation is noticed in the whole pedagogical process at various stages as listed below -

- Design teaching and its impact (i.e. impact of process)
- Students perception and Spark point / illumination phase(i.e. impact on the Person)
  - Creativity mapping
  - Cognition.
  - Design output (i.e. the creative score of the product)

Figure 1. The four parameters contributing to creativity and only product get evaluated.



## 1. Impact of Design teaching and learning process

There is a basic difference between teaching and learning process of design than other subjects. Basic 3 skills are used at large viz. (Knowledge [cognitive], Skills [psychomotor], and Attitudes [affective]). In design schools the pedagogical approach which is followed is very typical with less of innovation.

The end products are achieved by a typical design process without much innovation or creative inputs, lacking the major understanding of person's capabilities. Thus the impact factor of the pedagogical approach becomes the area of study.

## 2. Students perception and Spark point / illumination phase (Person)

### a) Creativity mapping.

Design teaching is a process which involves a lot of discussions among the peer group, student – teacher, student – subject specialist, experts and professionals. It is majorly a collaborative work which is recalled and produced in terms of output. There is always a gap between teacher's teaching and student's reception and perception that he recalls to reproduce. The gap becomes much wider when it comes to design evaluation, as the design process is time-consuming which is channelized by cognitive and creative thinking.

### b) Cognition.

There has always been a need to measure creativity in quantifiable parameters and to remove the bias due to the subjectivity of the evaluator. A deep research has gone in to frame the indicators and parameters for measuring creativity. Many tests are designed to measure creativity which target only some core issue and are case specific for a situation. The oldest ones had only one or two core areas to measure. The test's validity and reliability are being questioned during the comparison between old and today's computational one for the contemporary context.

There is a vast gap in the modulation or standardization of the units obtained from tests mentioned above. Lack of standardization in tests results in failure of lateral comparison of different input / stimulus, to prove the comparative efficiency of creative methods. None of the processes are efficient to judge the longitudinal parameters of creativity i.e. person, process and product, as well as the in-depth parameters of perception, incubation, illumination and verification.

Amongst the tests listed above none of the tests could be directly picked to evaluate the creative measurement in the design process as the tests are based on independent thought process not comprehensively detailed for evaluation of creativity in design. However, the measurement of thoughts and its intensity is evaluated only after the output. But the score is the reflection of compilation, presentation and quantum which any design could reflect at the end without quantifying the illumination and ideational level or the thought process involved in it. The focus of measurement of creativity, most of the time is not in the activity of brain / stimulus but the physical output of the design in isolation

## 2. Evaluation of Design output (Product)

Evaluation of design output is done by a group of people and their perceptions add to the subjectivity in the whole design process. The results are in isolation and hence need more parameters for evaluation of creativity holistically. Almost all the tests are designed in a closed loop and to judge few set of indicators, which are incapable of measuring in depth. A wide gap is observed for the holistic approach in

evaluation and measurement of creativity. A correlation is framed in terms of pre and post tests to conclude, but the 1st thought, the 1st ideation also matters, which is completely neglected. A lot of experience and thinking gets reflected with respect to time and knowledge and hence the 1st impulse needs to be mapped. Thus, there is a need for EEG / similar techniques in the whole design process to understand the impact of teaching objective to the learning done at individual and cerebral level.

## 3. Brain Mapping & Creativity

Brain mapping is currently a routine phenomena in medical science and an equally effective one. The techniques like EEG (Electroencephalograph), fMRI (function Magnetic Resonance Imaging), and PET (Positron Emission Tomography) commonly used for Brain mapping can also be deployed for measurement of creativity. The operational cost for the state of the art presided digital equipment of eeg is too high for them to be installed for educational institutes. The results from these are positively used for mapping the brain activity and relating the same to the creative output, critical output, non-creative activities etc.

## 4. Nature of interpretation

The brain consists of over 20 billion neurons which generate electric impulse. An electroencephalogram (EEG) is a test that detects electrical activity in the brain using small flat metal discs (electrodes) attached to the scalp. The brain cells communicate via electrical impulses and are active all the time, even during normal sleep hours. The electric impulse is measured in micro volts. This activity can be recorded as graphs depicting as much as 42 channel analyser for all mental activities and inputs to brain through sensory organs and self-generated activities during normal sleep mode. The test setup is split in three parts consisting of

EEG multiple probes attached to map the surface impulse of the brain,  
the analyser and  
the control interface with software for graphical display output.

The software gives following types of recordings for mthe major bifurcation in conscious and unconciour

-  
Alpha – Closed eyes

Beta  
Theta  
Delta. And  
Gama

The above are explained in the table given below.

Table 1 - Brainwaves, frequencies and functions

Unconscious		Conscious		
Delta	Theta	Alpha	Beta	Gama
0.5 - 4 Hz	4 - 8 Hz	8 - 13 Hz	13 - 30 Hz	30 - 42 Hz
Instinct	Emotion	Consciousness	Thought	Will
Survival	Drives	Awareness of the body	Perception	Extreme focus
Deep sleep	Feelings	Integration of feelings	Concentration	Energy
Coma	Trance		Mental activity	Ecstasy
	Dreams			

The graph i.e. the frequency plot of records obtained from multiple electrodes placed on the scalp. The neural oscillation is observed. The normal lines with less frequency and more amplitude results in rest mode.

The image of cerebrum with a colour index, light blue colour in the lower middle of the scale indicates the rest position. The yellow shades in middle and the red to maroon shades at the top indicating the higher electric impulse.

**EEG and its measuring parameters from literature**

In the core studies the EEG equipment from basic to advance are used to measure various parameters. Based on the limitation of this equipment six indicators are identified from literature and a correlation is formed.

- The behavioural measures if taken between mild and heavy cognitive loads, the graphs and charts provide significant differences with noticeable and recordable measures.
- The left and right brain activities if mapped shows a notable finding. The right hemisphere response positive to creativity and corresponding positive effect (Tucker 1988; Friedman & Förster, 2005).
- The alpha rating is giving a numerical value to the electromagnetic surface waves which is main purpose and objective of the research. Similar study was conducted by ( Norbert 2000 ). This study investigated the differences in cognitive processes related to creativity and intelligence using EEG coherence and power measures in the lower ( $\alpha 1=7.9-10.0$  Hz) and upper alpha band ( $\alpha 2=10.1-12.9$  Hz). In these experiments, gifted, creative, intelligent subjects, and individuals of average ability solved closed and open problems on EEG equipment.

- The electroencephalogram (EEG) is used to measure the difference between divergent thinking and convergent thinking. A similar experiment was done by Razoumnikova 2000 for divergent and convergent thinking in correlation to right and left brain activates.
- The experimented results can also be correlated to the standard results.
- Various subject groups were analysed for e.g.- Novices, Experienced , Age wise, Gender wise etc.

**Limitations of the standard equipment.**

- EEG gadget, in the present situation has been conceived for the medical purpose only and is not oriented to other applications. With the limitation of the equipment and its measuring parameters lot of restrictions need to be observed to conduct the experiment.
- The equipment being a medical gadget, its usage is restricted to a single individual hence activity in a group cannot be mapped at a single point.
- Mapping of collaborative ideation being the limitation of the equipment, it does not give a complete and complex pattern of thinking to give a holistic picture.
- Movements are restricted in most of the earlier versions of the devices hence documentation in hard copy happen after an interval when the test is over and equipment is removed.
- Individuals tend to give a deeper thought at documentation stage leading to error in experiment. Time laps in documentation (stationary set) are overcome in the mobile units making the system more adaptable.

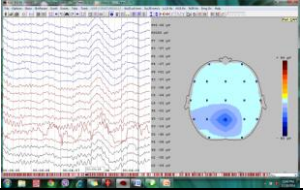
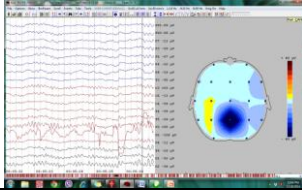
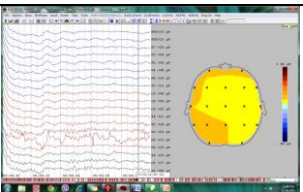
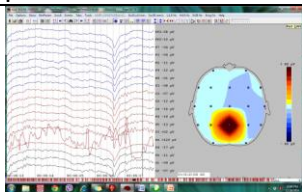
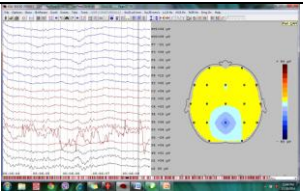
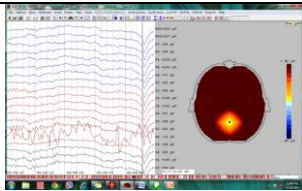
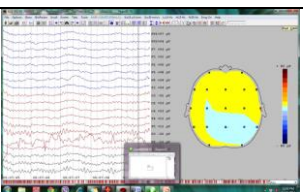
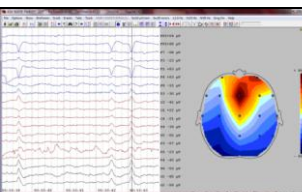
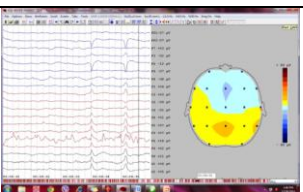
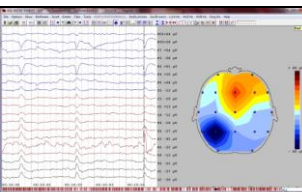
**3 METHODOLOGY**

The process is split in 2 stages- pilot study and sample study. Randomly picked Architecture students went through the experiment process . At the first stage, the students were relaxed, and the normalization of the student was achieved. The test is done in the relaxed position with closed eyes and without body moment. In the isolated ambience, the students were then put to a set of questions which ranged from near cognition to far cognition. It had a thinking task involved in it along with a creativity test. Lastly, the student were exposed to 2 stimuli, one verbal and other visual. In view of the limitation of tool for restricted body moment the documentation took place after the gadget was removed. The design outputs were evaluated and marked.

**Observations and inferences -**

The observations were marked, and the following inferences were drawn.

Figure 2. Step wise documentation of observation from the experiment conducted on portable EEG machine with architecture student.

	Stage 1 graph	Stage 2 graph
1		
At stable position		
2		
	Her home (near cognition)	(Further cognition)
3		
	Hotel she likes	Museum she likes
4		
	1 <sup>st</sup> 2 <sup>nd</sup> and 3 <sup>rd</sup> option	4 <sup>th</sup> and 5 <sup>th</sup> option
5		
	Verbal instruction	Visual as a stimulus

#### 4 INFERENCES –

The impulses measured by the probes were graphically interpreted by the software in the above manner. At the 1st place, the student was just asked to relax, and the light blue stage is seen in the whole image. Then the variation for near cognition and further cognition is mapped at 2nd and 3rd stage. When it was a near cognition, it was light yellow in

colour, and when it was the further cognition then it went to the deep red in colour. Indicating a lot of impulse going into the activity. At 4th stage of option making the 1-3 options were made in a most comfortable way where as to achieve the target of delivering 4th and 5th option the stress increased and larger surface was seen in deeper colour . At the 5th place, the pull factor was introduced i.e. a verbal pull or a Visual pull. The verbal pull had a middle range of impulses where as the visual pull had a higher range of impulses.

#### 5 . CONCLUSIONS

Design evaluation of the product (output) only gives the partial assessment for student’s understanding, the impact of teaching, Comparison between alternative methods, parameters for further improvements, etc. Electroencephalographs are the most accurate and cost effective tools to measure the process and person. It crisply measures the nodes for divergent to convergent thinking. It measures design creativity, maps thinking process, observing students reaction pattern, weaker zones in active teaching process with the maximum authenticity, time laps in the spark moments and magnitude of thinking. Whereas a detailed study with a wider sample is required to strengthen the observation. Thus, when the design is in process the person need to be evaluated for a longer time for better results .

EEG had shown the drastically different patterns [colour code] for a stay node to an active node in pilot study as well as in detailed study. The variation was seen for the near cognitive thought to farther cognitive thought. An interesting impulse pattern was observed in option generation satage. Less impuls is seen for the earlier options and more stress is seen for the later options.

EEG and allied systems being sensitive should be deployed for a holistic evaluation of the person and the process. Hence the means and methods of correlating the two techniques of evaluation – Traditional / Subjective and Scientific / EEG should be done elaborately to enhance the quality and level of evaluation.

EEG showcases the impulse levels and hence can actually assess a student who put an extra effort to do something than a Student who did it with less effort. Then correlating the same with the output will give the actual capabilities of individuals. The 5th place in figure No. - 2 the verbal stimuli is compared with the visual stimuli. The difference in two processes / pedagogical approaches is seen. Thus, it is concluded that if EEG evaluation is deployed for assessing design process, person and product. This method will be a standard for uniformity in evaluation and limiting or eliminating the subjectivity.

## RECOMMENDATIONS

The EEG equipment can have an extended application from medical equipment to an educational setup. This extended use of EEG with the same scientific principles with a high level of customization will be a boon for evaluation of the impact on teaching learning process. The head piece portability (already developed is rare) with software modification to map the bulk response in a comparative way is another area for exploration and experimentation. User interface should be considered to remove the phobia of the equipment for accurate results. The Scientific way of studio evaluation is Future of Design Studios.

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