**Are TRIZ and Mind Maps Two Sides of the Same Coin? Insights from a Chemical Product and Process Design Course**

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**Highlights**

* TRIZ and Mind Maps (MM) for creative problem solving
* Creative product and process design teaching and learning with examples
* TRIZ and MM examples in Chemical Product and Process Design
* TRIZ and MM feature comparison to explore creativity development as a thinking skill

**1. Introduction**

In the last decades chemical engineering has undergone great changes due to the evolution of the so-called commodities for high value-added chemical products where the main issues are centered on its performance and quality [1]. Since many of the chemical products currently have little to do with the products developed a few decades ago, the portfolio of skills and technical knowledge required by the new chemical engineers has also been changing in recent years. Nowadays, chemical engineers work with a wide range of products not only commodity chemicals but mainly specialty chemicals, devices for chemical change and formulated products, this last classically classified to cover a large body of industrial sectors (e.g. paints, cosmetics, inks, pharmaceutical, personal care, household, food) [2]. It is central to prepare students for the more flexible, diverse and creative role that they are expected to perform in Chemical Product and Process Design (CPPD) activity, mainly because engineering students do not see their training as requiring much creativity [3].This work compares and contrasts TRIZ and Mind Maps to explore creativity development in ideas generation, a very important step in CPPD procedure.

**2. Mind Maps and TRIZ in Chemical Product and Process Design**

The TRIZ theory is based on the premise that creativity means finding a standard solution based on the premise that somebody somewhere has already solved the problem or one like it and adapting it to the current problem [4]. Genrich Altshuller developed TRIZ which is also known as TIPS and acronym of Theory of Inventive Problem Solving and known as Systematic Innovation because inventive solutions share common patterns, making TRIZ a problem-solving philosophy based on logic, data and research rather than on intuition. On the other hand, other types of creativity tools based mainly on intuition are widely used. Some of the methods usually applied for creativity enhancement are brainwriting and brainstorming that are used to develop creativity based on the assumption that a quantitative increase of ideas will bring a qualitative improvement and one effective format to brainstorm generate ideas and get creativity development is the mind map [5] [6]. Looking at what is systematic innovation and for the intuitive processes of creativity it seems that these are at opposite poles with TRIZ suggesting a step by step excluding the intuitive approach and can be seen opposite to brainstorm and mind map techniques with try and error thinking. In this work we present examples from chemical product and process design course and we will use TRIZ and Mind Maps to explore creativity development and explore from the thinking skill perspective. Illustrative examples of mind maps are presented within the CPPD teaching and learning activities [7]. The potential of the maps to disclose students´ thinking about a topic of interest and to reveal connections and inter relationships between topics is highlighted as well as its role to develop student’s creativity and thinking skills. Illustrative example of TRIZ in chemical Process Industry is presented with focus on the major challenges experienced by Chemical Process Industries to develop more sustainable processes [8]. Through a TRIZ illustration on how to deal with operational problems that can reduce energy efficiency of a distillation process the systematic innovation approach is explained (i.e. the contradiction matrix and the inventive principles).

Based on the examples developed within the DPP course, both creativity approaches (i.e. TRIZ and Mind Maps) are compared to identify the main differences and the linking issues. The main characteristics of each approach are described and the advantages of each are highlighted.

**3. Conclusions**

Despite the differences that exist between the systematic innovation of TRIZ and the intuitive processes of innovation where brainstorming and mind maps take place it can be concluded through the advantages identified in each method that the approaches are complementary and are the two sides of the same coin in creative problem solving and the combination can likely lead to creativity among students and development of higher order thinking skills.

**References**

1. P.M. Saraiva, R. Costa, Trans IChemE, Part A Chem. Eng. Res. Des., 82(A11) (2004) 1474-1484.
2. R. Costa, G.D. Moggridge, P.M. Saraiva, AIChE J., 52(6) (2006) 1976-1986.
3. K.L. Hohn, in Proceedings of the 2010 Midwest Section Conference of the American Society for Engineering Education, http://www.asee.org/documents/sections/midwest/2010/19\_Hohn.pdf.
4. G.S. Altshuller, Creativity as an Exact Science. The theory of the Solution of Inventive Problems. Gordon and Breach Publishers, 1984.
5. T. Buzan, Use Your Head. Innovative Learning and Thinking Techniques to Fulfil Your Mental Potential. BBC books, 1974.
6. T. Buzan, B. Buzan, The Mind Map Book: How to Use Radiant Thinking to Maximize Your Brain's Untapped Potential. BBC books, 1993.
7. IM. João, J.M. Silva, IJEP, 4(5) (2014) 42-48.
8. I.M. João, J. M. Silva, IJoSI, 4(4) (2017) 15-25.