

Teaching Technical Students Industrial Process Engineering

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Abstract

Pursuing the current tendencies, this paper aims at presenting a method of teaching process engineering to students, during the entire university period of studies. This method will easily cover the degree programmes and as well as the master studies, building a bridge between academic and industrial fields. Besides technical issues the essential of industrial continuous improvement methodologies are considered. Using simple methodology tools as SMART, Brainstorming, Eisenhower, Ishikawa, PDCA and SWOT students should buy in the industrial analysing approach. Without these kinds of tools, the technical knowledge by itself is incomplete in the industrial environment. A future specialist combining the critical thinking, curiosity and technical knowledge becomes a valuable HC for the company he will perform into. Within this paper I highlighted practical examples of learning process engineering methodology. In order to have an approach process based I underlined the input as the graduate recommended features and the output as the job profile of a specific industrial role. The positive measured impact and feedback after each generation of students assured me that we are on the right learning track.

Keywords

lean, student, human capital, job

1. Introduction

More and more often comments initiated by professors and parents are arising regarding this argument: the children/students are different today and they are not resembling with us! The below table 1 shows the major changes between the expectation we had from a child/student in 19-th century compared with 21-st century [1].

Table 1. Comparative study between 19-th century and 21-st century – major changes [1]

19-th century	21-st century
Do the right thing	Be an adventurer, open new doors of knowledge
Must listen	Work together Team player
Must accept	Ask questions! Everything is questionable
Highlight the passivity of the student	Very active student
Storage and reproduction of the lessons	Imagining the solutions for different categories of problems
Respect	Initiative
Follow the received instructions	Take over the responsibility
Evaluation by the professors	Self-evaluation

These changes are basically positive and sometimes are taken over by the students as an extra liberty, skipping the responsibility which is coming along with this. Due to this gap the scholarly literature defines the so-called elastic children, in the present case elastic students [1].

The elastic students are those returning to the starting point (forbidden point) in the moment when the professor is not paying attention to them.

At all times it must be taken into consideration the technology factor which is influencing the children, pupils and students, resulting in the generation of digital childhood and digital individuals [1].

So, nowadays we have the premises of new types of students. These typologies must be recognized by professors who should adapt accordingly, in the most efficient and effective ways, owing the fact that in order to be efficient, the pedagogy must be active and interactive.

The obvious problem consists in the fact that students are not trained in seeing the problem in the process. They are acquiring data, without reacting when a process is not pursuing the technical and quality specifications and requirements. In order to eliminate this aspect, I challenged the class using teaching through lean methods. I am convinced that we can master and teach the methods performed within the industrial domain.

Based on the above mentioned, some questions are to be considered when someone tries to change the actual learning system paradigm [2]:

- Why to change?
- What to change?
- How to change?

Knowing your auditorium (students) means acknowledging the background, motivations, interests, availability, curiosity, opportunities.

Discussions and methods development are conducted during the seminars activity which are focused on interaction between lecturer and student, these parties being equally involved in the overall activity.

A plus to be taken into consideration is the preparation by the students themselves of the individual or team presentations which they will defend during lectures. For the successful completion of their project, the students will have to use different sources to find the necessary information needed to be presented during seminars or courses to the other students. The aim is to determine them to get used to look for information on the internet, looking for catalogues, or in companies references and specifications, as a result being able to explain principles, methods and processes [3].

Open discussion with the students encourages criticism and creativity; at the same time creates open minded perspectives and determines intensive focus on communication and interactivity.

As a case study, I hereby present how thinking centered on process is illustrated in this situation by teaching and applying the lean methodology.

As stipulated within ISO9001, I focused the entirely teaching/learning activity on process. This involves clear identification of the process steps, input values and output values.

2. What Is Human Capital?

Let's try to respond to the following questions: what is human capital, which is the most appropriate candidate profile and how could the methods discussed here to improve this profile.

Human capital management is involving a synergy between individual and the employer (organization). The human capital is the main key process indicator of the organization performance which is activating within a company and an international informational economy. The human capital, defined as an individual characteristic, it is a combination of genetic features, education, experience and attitude regarding a labor contract and not limited to this. The current state refers to employee as human capital because nowadays the organization is focusing on its human potential [4].

Continuous improvement in all business organization can be achieved through investment in the human capital, increasing in this manner the value added of this process input, the competitiveness, and unlocking the human potential.

The economic environment is continuously changing, and its demands are so various from year to year. Consequently, the students and professors must adapt, correlating the curriculum with new skills and competences to be able to satisfy the industrial demands [4].

In contradiction to the traditional organizational concept "human resources", the development of the employees is not any more considered a simple cost. Nowadays it is considered a strategic investment according to the strategical KPI (Key Performance Indicator) [4].

The development of the employee's human potential can be easier accomplished if the society would start this process earlier, meaning during the university studies. In this transition phase, from high school to junior employee, I find the involvement of academic factors critical.

During the study period for this analysis I have organized visits to industrial companies in order to facilitate for the students' real experiences within manufacturing processes.

Another feature which must be developed is the communication and beyond this communication in technical English language.

Aspects which have to be considered during the academic learning period – morality, civic, ecological, sustainability and balance the amount of information versus allocated time.

Focus must be directed towards student motivation and towards the struggle to keep him engaged within the teaching-learning synergy. An important aspect that must be considered consists in the fact that students are more emancipated year after year. They must find their own motivation and vision reported to what they learned and where they are working on (if applicable).

3. Candidate Profile

It is a fact that candidate profile accompanies the job description. It describes the features of the ideal person for a specific job and can be elaborated following a given structure [4, 5]:

- Personal competences: what has to know the individual and has to do in order to fulfil his role.
- Skills and professional training: professional and technical qualifications, or the requested studies.
- Experience: work categories or organizations, type of activities and results which could indicate the probability of professional success.
- Specific requirements: what a company expects from the candidate besides the specified jobs / domains.
- Compatibility organization-individual: organization culture and the necessity that future employees be able to work within.
- Special conditions: work travel, delegation, overtime hours, mobility, flexibility etc.
- Fulfilment of candidate expectations: career development and professional training [5].

Students must be aware of the future requirements and features from a job profile.

I highlighted them, as divided in demands and resources, in the below synthesis (Table 2).

Table 2. Overview of the demands and resources regarding a job

Demands		Resources	
Physical demands	Quality of the work environment	Feedback	Job security
Mental demands	Work conditions	Learning the value of the job	Organizational justice
Emotional demands	Work schedules	Autonomy	Social support
Workload		Task variety	Leadership
Effort – reward imbalance		Skill discretion	Pay
Demand – control imbalance			Organizational climate

4. Job Profile

For the case study I analysed the job profile of a Health and Safety Inspector. Based on students' perspective the main features highlighted are gathered in Table 3 and Figure 1.

Table 3. Health and safety inspector profile – student perspective

Attitude	40%
Studies	30%
Competences	25%
Chance	5%

For specific analyses and understanding, I presented to the students the job profile asking them to start a self-evaluation in order to see how well are they prepared for such a job (Table 4 and Figure 2). They rated each feature individually, as shown below.

Table 4. Inspector Health and Safety Inspector - job profile – Students’ rating

No.	Feature	Subjects / Rating											S
		1	2	3	4	5	6	7	8	9	10	11	
1	Experience	3	4	4	3	3	3	3	3	3	3	3	5
2	Attitude	2	2	3	3	3	2	4	3	2	3	3	5
3	Specific training (Safety&Security)	0	4	0	2	0	0	2	0	0	4	4	5
4	Word/Excel	2	3	4	3	3	4	3	3	1	3	4	5
5	Skills	2	3	4	2	3	3	3	4	1	4	2	5
6	Responsibility	4	4	4	4	4	4	3	4	3	4	4	5
7	Adaptability	3	4	3	4	4	3	4	3	3	3	3	5
8	Occupational health service	0	0	0	1	0	0	1	1	0	0	0	5
9	Analysis	3	3	3	3	3	3	3	4	3	3	3	5
10	Problem solving	2	3	4	4	4	3	3	3	3	3	3	5
11	Communication	2	4	3	2	4	3	3	3	2	3	3	5
12	English language (conversational)	3	2	3	1	3	3	3	2	3	2	2	5
Final rating		26	36	35	32	34	31	35	33	24	35	34	60

S - standard (maximum rating)

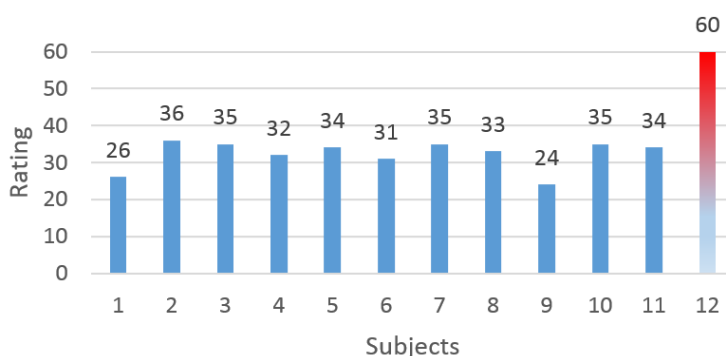


Fig. 2. Final students rating

5. Practical Use of Different Lean Methods

As part of the teaching methodology, I started by integrating basic knowledge which almost two decades is fundamental of lean tools applied within the industrial environment. These methods have been adjusted and adapted according to the auditorium capacity to understand and reflect upon.

5.1. SMART Objectives

I started by highlighting the importance and the relevance of setting clear goals in life and in the class in order to be able to measure the input and the output. In a single expression: to apply the SMART tool, in accordance with the criteria set by the acronym:

Specific (simple, significant, detailed) – to be elaborated in such a way that can influence the behaviour;

Measurable (metrics, values) – to facilitate the measurement of the scope / objective;

Achievable (Attainable) – to be able to accomplish the goal. If is too enthusiastic, optimistic or unrealistic it will generate frustration in the end;

Relevant (realistic) – connected to the desired output of your strategic plan or project scope;

Time bound (time frame set) – you need to set a finish date/ hour for implementing an objective. Time frame should be reasonable and achievable [6].

These objectives must be periodically evaluated and reviewed.

Essentially, we have been using during our classes case studies for better understanding of the keystone. For example, I defined the following case and we analysed it together during classes, trying to refine it as much as possible with the team members (students).

Example of case study (SMART objectives definition)

Scope: Health and Safety semestrial exam

S – 1 written exam

M – 20 questions with one possible answer

A – 10 lessons (bibliography)

R – given minimum grade

T – 20 minutes

5.2. Creative ideas through Brainstorming

Following the main idea of this paper the next tool used during the class was Brainstorming. Having the previous tool in mind (SMART) we must choose the scope and refine it according to the lean principles to be as efficient and effective as possible.

Example of case study

Scope: Elimination of Poverty (individual)

Main steps:

- a. Refine the scope!
- b. Assemble the team (the class)
- c. Define the rules!
- d. 10 minutes thinking and writing
- e. Each member is saying his points
- f. Points are written on the white board by the facilitator (professor)
- g. Sorting the points
- h. Rating the points
- i. List of open points with focus on What/ Who/ When

Main ideas of the students have been gathered and structured within the following table (Table 5).

Table 5. Input from Brainstorming

Rate	Idea	Rate	Idea	Rate	Idea
4	Searching for a job	4	Accessibility of the jobs	4	Changing the job
4	Cost planning	4	Priority list	x	Relocation
2	Skills	1	Gave up smoking	2	Second job
x	Savings	1	Compulsive (stupid) shopping	x	Enlarge the group of friends
x	Reduce the group of friends	2	Skill training	2	Refresher training
x	Choosing better the close friends	x	Eliminate the Delusions of grandeur	2	Own business (start-up)
1	Taxes elimination	x	Raising the minimum wage	2	Study
2	Documentation	2	Education	3	Will
3	Aspiration	2	Charity activities (foundation)	4	Progress plan
4	Measurable targets	x	Vocation (e.g., priest, vocalist)	4	Objective assessment
4	Time planning	1	Reduce the time spent in restaurants	1	Gave up TV
1	Gave up driving own car for short distances	x	Speculative investments		

Remarks:

x – ideas which are not taken into consideration for the purpose of this exercise, but haven't been deleted)

1 - Taxes/ Driving/ Smoking/ Shopping/ Restaurants/ TV

2 – Skills/ Documentation/ Training/ Education/ Foundation/ Job/ Start-up/ Study

3 – Aspiration/ Will

4 – Job/ Cost/ Targets/ Time/ Accessibility/ Priority/ Changing/ Progress/ Objectives

By the foresaid method, we should be able to analyse the mechanisms of defining and refining of “what has to be done”, and in this case, who and when is the student's responsibility to take upon.

The student must understand, by tireless practising more that in real cases, that Who and When are the critical features for a successful plan. For sure, for an enhanced approach, within the plan questions we can also include features like How (way of handling the task) and How much (cost).

5.3. Prioritization using Eisenhower method

This line of teaching, on the premise of a well-defined scope and plan, will help, in class and furthermore, in life, to know in-depth your priorities.

I proposed to the students one of the tools, the Eisenhower method.

Example of case study

Scope: Future graduate student lack of time to prepare according to the requirements of the final exam.

How to define what is urgent versus what is important? So, we started to share points of view, refine, debate and in the end decide as a team (Figure 3).

IMPORTANCE	More	II. Extremely Important / Not urgent a) Study for exam b) Rest c) Information understanding	III. Very Important / Very Urgent a) Prepare the documentation for dissertation b) Communication with the tutor c) Medical analysis
	Less	I. Not Important / Not Urgent a) Social media b) TV serials; Online serials c) Small talks	IV. Not Important / Very Urgent a) Alimentation b) Breaks c) Movement
	Assignment / Task	Less	More

Fig. 3. Prioritization using Eisenhower method

5.4. Act using PDCA

A structured approach is recommended to be used as we defined our actions and we want to start to act. I chose the well-known tool PDCA (Deming circle). A simple explanation of the acronym is as following:

- Plan – planning, documentation;
- Do – pilot activities, initiatives;
- Check – checking, auditing, analyse the results;
- Act – action, implement, standardise.

For a better understanding of this tool, I highlight in (Figure 4) the steps to be followed in for a successful approach.

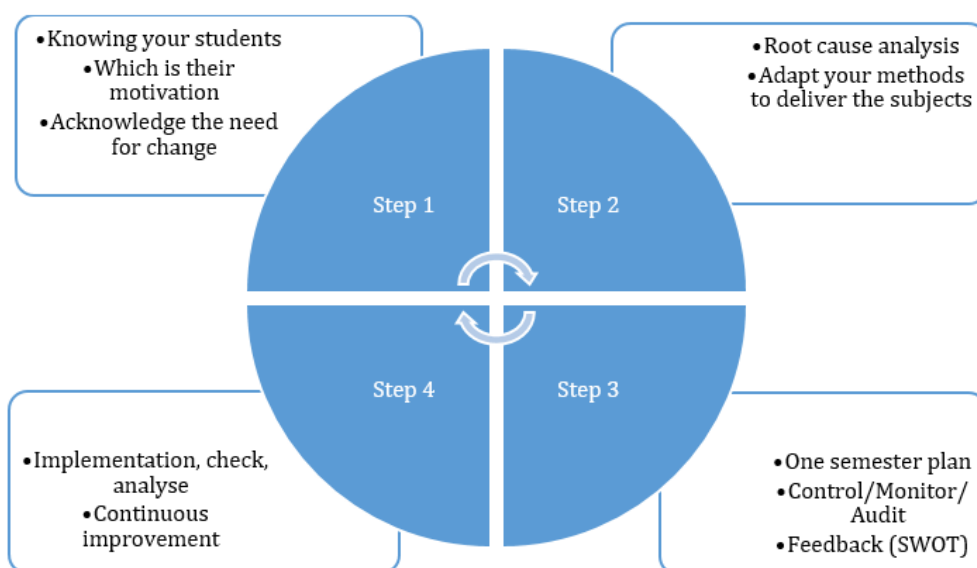


Fig. 4. PDCA cycle applied in the class to keep the teaching and learning process up to dated

5.5. Analysis based on Ishikawa

Below I present an exercise focused on a case study, analyzed together with the students regarding the causes that affect their lack of efficiency in getting a job. It was important to ask the right questions to achieve answers conveying to scope of the method, to understand the difference between cause and effect and the direct relation between those two features (Figure 5).

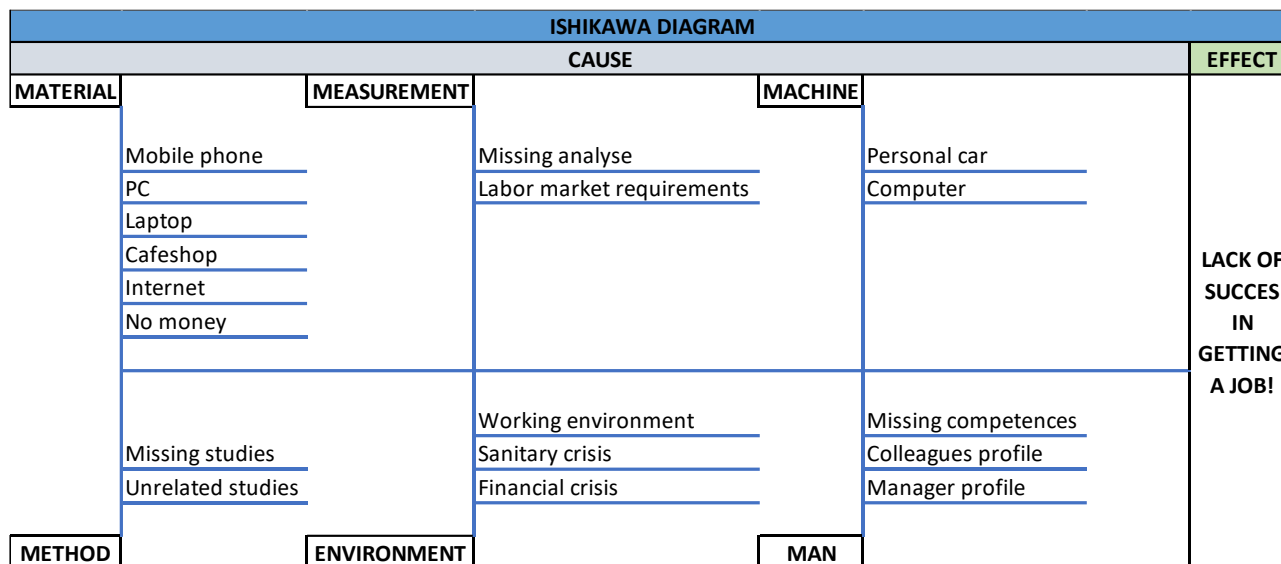


Fig. 5. Ishikawa diagram

5.6. Use SWOT for feedback

To complete the proposed lesson scenario for students I will mention also the SWOT tool used during the class. The meaning of this acronym is:

- S – strengths (internal factors, strong points)
- W – weaknesses (internal factors, weak points)
- O – opportunities (external factors, improvement points)
- T – threats (external factors, can harm points)

I organized the data achieved during SWOT performance for a better understanding of the information (Table 6).

As a result of the challenging activities, I have discovered as main characteristic of students’ performance the enthusiasm towards interactivity of the learning environment. Critical questioning for elucidation and interpretation of the presented methods were also appreciated.

Example of case study

Scope: Semestrial specific subject teaching

Table 6. SWOT analysis - Semestrial specific subject teaching

Internal factors		External factors	
Strengths	Weaknesses	Opportunities	Threats
Interactive	Qty. of information vs time	More practical	Companies’ visit
Questioning	Technical language	More companies’ visit	Not enough time
Testing	Structure	Intermediary tests	Vocational training
Openness	Specific explanation	Ranking of the methods	Intermediary tests
Dedicated/ Critical	Focus	No final exam	Without final exam

This method assures the necessary feedback from the students and it is one of the best evaluation methods used for evaluating your Teaching and learning process efficiency and efficacy.

6. Conclusions

Using industrial methodologies, it is mandatory for the professors to build „bridges” between the industrial and academical domains.

The professor must act as the liaison between the two fields by using mutual understanding of the basic principle.

Nevertheless, the professor has to keep under control the fact that not all the students or graduates will activate within an industrial domain.

The focus was on basic principles which can be applied no matter the future professions or jobs chosen by the graduates’ students.

This paper is revealing an intro of process engineering methodology to the students using simple tools and there through creating a bridge of knowledge towards the industrial economic environment.

Graduates’ features and specific jobs profile have been highlighted in order to find the common grounds among them.

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