Comparative analysis of a pilot experiment's outcomes, at the Vishnu Educational Development and Innovation Centre, of the COACH_ING model in use at the Sapienza Faculty of Civil and Industrial Engineering

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Abstract. In the context of modern training approaches and the needs of a constantly evolving job market, a comparison is made between an experimental model in use for six years at the Faculty of Civil and Industrial Engineering of the Sapienza University of Rome and a pilot experimentation by the Vishnu Educational Development and Innovation Center (VEDIC) in India. We want to examine the characteristics of future engineers who undergo soft skills training to evaluate the effectiveness of the program. Soft skills assessments, aimed at guiding conscious professional choices, represent a potential model for the training of engineers.
The objective is to evaluate the effectiveness of multiple hybrid interventions using a coaching model that integrates the programmatic skills of engineering and the relational skills of coaching (COACH_ING).
The experimental methodology adopted, implemented by VEDIC, is based on the light assessment of the COACH_ING model. The approach used within Sapienza has evolved to include 16 specific transversal skills. Light assessment allows the collection of data from groups of students undergoing different training interventions. The self-assessment data on the acquisition of transversal skills, collected using our tools at VEDIC and Sapienza, were compared. This comparison allowed us to identify the skills most developed by the students and to compare the perceived level of mastery between the control and test groups. This pilot project will highlight the importance of projects such as the "Train to Career", in order to facilitate students to make informed career choices.

Keywords: Assessments, Engineering Training Methodologies, Education.

1 Context

The following paper shows the development and results of a pilot experiment carried out by the Vishnu Educational Development and Innovation Center (VEDIC) in India, through the use of some tools of an innovative training model, called COACH_ING

[1][2], used by 6 years in an experimental laboratory at the Faculty of Civil and Industrial Engineering Sapienza. This study aims to examine the similarities and peculiarities of the educational paths and characteristics of engineering students in terms of the development of soft skills, in order to evaluate the effectiveness of the experimentation and the possibility of subsequently implementing the entire laboratory program.

Soft skills have become increasingly important in the contemporary professional world, and this also includes the field of engineering. The assessment of soft skills as part of the "Train to Career" program [3], aimed at guiding informed choices for entry into the job market, can represent an innovative and replicable model for engineering training at a global level.

In particular, the classroom methodology, the evaluation tools and the results obtained in the two institutions will be analysed, highlighting the differences in perception of soft skills. This comparison will provide valuable insights to improve training programs aimed at orienting students in any field, making them more in line with the needs of the global market and helping to train aware and versatile professionals [4][5]. The hope is that such initiatives will not only raise educational standards, but also promote greater international collaboration in engineering education and beyond.

2 Purpose

The work carried out aims to evaluate a new experimentation of the educational model born from the integration of the programmatic skills of engineering and the relational skills of coaching [6] (COACH_ING), which integrates blended methodologies, online and in the classroom, of an innovative laboratory, applied in a geographically distant but culturally similar context, through modules and tools for the development of transferred and shared skills and to monitor future growth. Developing training models based on self-assessments and mutual assessments in a larger network represents the arrival point of this particular application. The experimentation and the consequent analysis of the results has, therefore, the objective of verifying the effects of the methodology on the development of the transversal skills covered, also observing any differences potentially determined by the cultural differences deriving from the different geographical location of the participants involved, first during the experimentation at the Sapienza university, and now by VEDIC.

3 Approach

The engineered training and coaching methodological approach (COACH_ING), used at Sapienza, in the context of placement workshops and orientation and tutoring seminars, finds its roots in coaching and engineering skills [7]. These 16 skills were selected over years of experimentation at the Engineers' Council of the province of Rome and at the organizations operating in the technological sector in which the training model was used. Fig.1 shows the 16 skills of the model, highlighting which have been borrowed from coaching and which have been chosen from the programmatic and systemic skills used and developed by the engineers during their training path. [1]

COACHING			ENGINEERING
	Adaptability	Analysis and Synthesis	
	Intercultural Sensitivity	Initiative and Energy	
	Communication	Decision making	
	Creativity and Innovation	Work, time and resources organization	
	Relationship Building	Prospective Thinking	
	Assertiveness and Influence	Orientation to result and task	
	Social Intelligence	Proposals and Projects	
		Self-investment	
		All-encompassing Vision	

Fig. 1. The 16 COACH_ING skills

The classroom methodology uses these 16 skills as reference dimensions for development and as tools for the self and mutual evaluations of the participants in the courses. In its complexity, the Model has been enriched over the years with multiple tools [8] following the process and method schedule defined in the first years from 2014 to 2016 during the coaching experiments in extended classrooms [1][9]. During the experimentation that is the subject of this work, we referred to the stage of the model in the year of covid (2019-2020), a year in which we worked mostly online and with many restrictions. In these circumstances we carried out the university laboratory called "Soft Skill of today's engineer" in blended mode, but taking into account only those present on site (max 2 students allowed with 2 teachers per classroom) it can be said that the "train to career" has been successfully applied in online-only mode [10][11]. By train to career we mean the methodology aimed at making everyone a trainer/teacher capable of transferring their best skills to others within the same classroom or work group [3].

In that year, not being able to always experiment with the skills in presence as in previous years, given the limitations of the connection tools for doing online group work, we involved male and female students in a game in which each would "adopt" a competence, of the 16 of the model, and then transfer it to their classmates. Precisely on this basis we built our first experimentation and collaboration with VEDIC.

The approach adopted within Sapienza, over the years, has seen an evolution through the integration of assessment tools that verify the 16 skills related to coaching and engineering (in terms of perception of mastery/confidence), promoting the acquisition of knowledge and the development of competencies, both used individually and combined. The light assessment, applied to students of different university classes, is structured in such a way as to collect data at different times and on groups of students subjected to both traditional curricula and training based on coaching and educational stimuli, as well as group and experiential activities. In this particular experiment it was chosen to use the tool of the 16 COACH_ING Skills (C_I) and that of the Communication MicroSkills (MSC) to evaluate on the one hand the confidence with our transversal skills (the 16 C_I) and on the other to assess familiarity with factors related to communication skills.

The experimentation by VEDIC was conducted through the following steps:

3.1 Step 1 of the experimentation

During the first day of the experiment, the students (female students in the second year of studies at BVRIT Hyderabad College of Engineering for Women) self-assessed, through a Google Form, their perceived level of mastery of the 16 COACH_ING Skills and the 4 Communication MicroSkills on a scale of 1 to 5 where 1 was 'not confident' and 5 was 'very confident' [3].

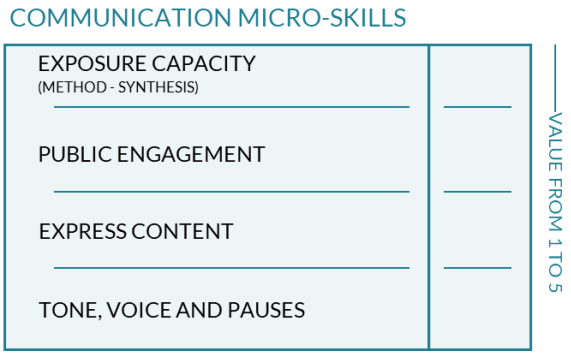

Fig. 2. The 4 Communication MicroSkills

Following this first phase, the students were divided into two groups respectively called "TEST GROUP" (TG VEDIC) and "CONTROL GROUP" (CG VEDIC). The CG VEDIC students were dismissed and told to continue their studies and lessons as usual and were informed that they would be contacted again after a month for a second self-evaluation. The TG VEDIC students were instead instructed on the activities they would have to carry out in the following week. The activities assigned to the TG VEDIC, which we asked not to communicate during the period of the experimentation with the members of the CG VEDIC regarding the topics covered, are described below:

- Each individual student was assigned, through a draw, a skill between the C_I and the MSC to "adopt" and work on. This first operation was carried out through a draw to ensure that each skill was assigned to a single student.
- Each TG VEDIC student was asked to do a brief research on the "adopted" skill and, subsequently, draw up a document in which to describe what they had learned about the skill.
- Finally, each student was also asked to prepare a PowerPoint presentation in which to clearly and concisely include everything they learned about their "adopted" skill.

To compare the data collected with the previous ones, we used a collection system that guaranteed the privacy of participants identified by their ID.

3.2 Step 2 of the experimentation

After a week, the TG VEDIC students were called back and presented the results of their research on the assigned skill in front of their classmates. In this way the students,

independently, had the opportunity to experiment with C_I and MSC skills through individual study and sharing what they learned with their colleagues. After the presentation of all the skills, the students were encouraged to use what they had learned and commit to strengthening the 20 skills of the model used during the experimentation.

3.3 Step 3 of the experimentation

After 3 weeks, as previously communicated to the students, we called back both the TG VEDIC and the CG VEDIC to carry out the second self-assessment of the C_I and MSC skills. Having reached this point, the students of the TG VEDIC presumably had the opportunity to increase their awareness of the model's skills through the activities carried out up to that point (although carried out independently and in a relatively short period), while the members of the CG VEDIC had continued their studies, as usual, without any intervention from the team at VEDIC that managed the experimentation. Once this last phase was concluded and the data had been collected, we therefore moved on to the last phase of the project, analyzing the data and comparing them with those previously collected during similar activities carried out at the Sapienza University of Rome.

4 Actual Outcomes

The data shown in Table 1. emerged from the analysis of what was collected at Sapienza University and during the experimentation carried out by VEDIC at BVRIT Hyderabad College of Engineering for Women.

Table 1. Aggregate and compared data from Sapienza and VEDIC CG and TG

	SKILLS	CG SAPIENZA		TG SAPIENZA		CG VEDIC		TG VEDIC		CG SAPIENZA	TG SAPIENZA	CG VEDIC	TG VEDIC
		START AUTOEVAL AVG	END AUTOEVAL AVG	START AUTOEVAL AVG	END AUTOEVAL AVG	START AUTOEVAL AVG	END AUTOEVAL AVG	START AUTOEVAL AVG	END AUTOEVAL AVG	Variation	Variation	Variation	Variation
16 COACH_ING SKILLS	Adaptability	2,80	2,90	3,80	4,60	4,00	4,18	4,27	4,27	0,10	0,80	0,18	-0,02
	Analysis and Synthesis	2,50	2,65	3,40	4,40	3,82	3,82	3,64	3,91	0,15	1,00	0,00	0,18
	Assertiveness and Influence	2,20	2,20	3,40	5,00	3,82	3,55	3,91	3,82	0,00	1,60	-0,27	-0,11
	Communication	2,40	2,95	3,00	4,80	3,82	3,91	4,36	4,18	0,55	1,80	0,09	-0,19
	Relationship Building	2,80	2,85	3,40	4,80	3,91	4,00	4,45	4,18	0,05	1,40	0,09	-0,30
	Creativity and Innovation	2,00	2,35	4,00	4,80	3,55	3,73	4,27	3,64	0,35	0,80	0,18	-0,36
	Decision Making	2,44	2,75	3,40	4,80	3,82	3,45	4,27	4,09	0,31	1,40	-0,36	0,10
	Initiative and Energy	2,90	3,35	4,40	4,60	3,73	3,82	4,18	4,09	0,45	0,20	0,09	-0,18
	Social Intelligence	2,60	3,35	3,40	4,80	3,73	3,64	3,91	3,73	0,75	1,40	-0,09	-0,17
	Self-investment	2,80	3,60	3,40	4,80	4,09	4,09	3,91	4,09	0,80	1,40	0,00	0,22
	Work, time and resources or	2,70	3,20	3,60	4,80	3,91	4,09	3,73	4,00	0,50	1,20	0,18	0,34
	Orientation to result and tas	2,80	3,35	4,00	5,00	4,00	3,91	3,82	3,73	0,55	1,00	-0,09	0,12
	Prospective Thinking	2,30	3,00	3,80	5,00	3,91	3,91	3,82	4,00	0,70	1,20	0,00	0,06
	Proposals and Projects	2,40	2,80	3,60	5,00	3,55	3,64	3,73	3,73	0,40	1,40	0,09	0,06
	Intercultural Sensitivity	2,80	3,20	4,60	5,00	3,55	3,55	3,73	3,73	0,40	0,40	0,00	0,12
	All-encompassing Vision	2,50	2,95	3,00	4,60	3,82	3,73	3,45	3,82	0,45	1,60	-0,09	0,42
COMMUNICATION MICROSKILLS	Expressed content	3,11	2,80	3,50	3,83	3,91	3,91	4,00	3,82	-0,31	0,33	0,00	-0,06
	Tone, voice and pauses	2,83	2,15	3,00	4,00	3,73	4,00	4,09	3,55	-0,68	1,00	0,27	-0,40
	Exposure capacity	2,81	2,50	3,08	4,09	3,91	3,73	4,00	3,91	-0,31	1,01	-0,18	0,06
	Public engagement	2,81	2,80	3,08	3,51	4,00	4,09	4,00	4,00	-0,01	0,43	0,09	0,12
		SECTION 1		SECTION 2						SECTION 3			

The previous table is organized into three sections: the first section illustrates the skills that the students self-assessed using the model tools, the second section shows the

aggregate results (average) of the self-assessments carried out by the students. In the first four columns there are the data from the experimentation carried out in 2020 on two groups at Sapienza (Test Group and Control Group), and in the following four columns the data relating to the two groups of the experimentation by VEDIC. The self-evaluations have been done in two distinct moments (START for the first self-assessment during Step 1 and END for the second carried out during Step 3). In the third section there are data relating to the change in the level of confidence/mastery perceived relative to the skill of the corresponding row.
Remembering the process described above, we note that the CG VEDIC changed its confidence in a limited way, which reflects the inactivity of the members during the experimentation period, during which the students did not carry out any in-depth study or reflection, in addition to curricular ones.
The TG VEDIC, on the other hand, shows more variations. Given that, presumably, the students, following individual study activities, cannot have reduced their mastery with the skills covered, the data highlights an increase in awareness on the real meaning of the transversal skills of the model and a re-evaluation of their level of mastery with them.

The most varied skills in the current experiment are "**Creativity and Innovation**" and "**Tone, voice and pauses**". The data relating to the second skill are most probably indicative of the students' unfamiliarity with the skills for effective communication and how much, following the in-depth study and more importantly their practice of aspects of communication during their presentation sessions, they changed their perception. The possible reasons that may have led to the reduction in confidence in the first skill, are more difficult to interpret. It is possible that this variation could be linked to the lack of creativity in having to construct an interesting and captivating presentation for colleagues. The student population of the experimentation by VEDIC is exclusively female and the low level of perceived mastery in "**Assertiveness and Influence**" and "**Decision Making**", in the CG VEDIC may potentially indicate the low level of exposure to these concepts in their previous education and could have some cultural context as well and needs to be studied further.

The result of the experimentation is to be considered satisfactory, as the objective of the model is to increase awareness, thus also developing the students' ability to self-evaluate and self-orient towards the areas of improvement that are of most interest and which can be most useful to them. We also want to draw attention to the variation data from the laboratory carried out at Sapienza (**TG SAPIENZA**) and of the **CG SAPIENZA**. A greater increase in mastery level is not unexpected, given the greater availability of time and more direct contact with interested students; however, the increase is too marked to be considered "concrete". Analysing the data in Table 1. has highlighted a need and influencing factor that had already been brought to our attention during the latest studies: the subjects, **if not adequately informed about the concept of confidence**, mastery and the **in-depth meaning of the skills covered**, **tend to self-evaluate at the extremes of the Likert scale** and often overestimate their own growth. In fact, during the workshops carried out at Sapienza up until the edition in the Covid period, students were not offered a clear definition of the concept of confidence, and the "extreme" results are very likely to depend precisely on this lack. Obviously, there

is no real "maximum level" of mastery of skills, given that it is relative and depends on one's own needs and on the comparison made with others, nevertheless, for any self-assessment tool to be valid it is necessary that measurability of the dimensions has a reliable reference point.

The CG SAPIENZA also showed a similar trend, having relatively high increments in their C_I skills final self-assessment. On the other hand, the MSC skills have seen some decline which indicates a collective increase in awareness. This group did not take part in any of the test group activities and the students did not communicate in the experiment period so the change in mastery perception can be attributed to self-reflection (especially observing peer students and professors), to the students deciding autonomously to reconsider their knowledge of the micro-skills or to other external factors or situations that might have caused the students to reassess their previous evaluation.

To further explore these aspects and the reasons behind the variations in perception, it would be of great interest to submit a survey to all VEDIC participants to collect feedback on the how they carried out their self-assessments.

5 Conclusions

Data analysis reveals variations in approaches and the acquisition of new skills, thus providing ideas to guide future applications and experiments aimed at optimizing and improving the tools used in this light assessment, already tested beyond borders. The students' perception of their own level of mastery/confidence with the skills covered presented a significant difference in variation for the students of the TG VEDIC compared to those of the CG VEDIC, but it is necessary to delve deeper into the reasons that guided the students to self-evaluate with their respective values. Experimentation, therefore, is effective for improving students' awareness of transversal skills, including those specific to communication, and can therefore be used to guide students towards improving them. The strong need to provide the subjects involved with precise information on the self-assessment scale was also confirmed to avoid "exaggerated" or unrepresentative data.

This indicates the need to introduce within the study programs activities aimed at strengthening and increasing awareness of transversal skills, as basic curricular training does not sufficiently deal with these aspects of the educational and professional sphere. Furthermore, it is considered necessary to introduce evaluation tools into engineering education to be made available to teachers in each university course to stimulate even just an initial awareness or sensitization of the need to integrate at least the basic elements of communication into their specific engineering training [12]. Strictly necessary skill to convey and transfer notions/information in one's professional and research activity.

The next step of our experimentation in collaboration with VEDIC could be to organize online insights based on group work focused on the basic elements of communication and how they are interconnected with other indispensable skills such as the ability to build relationships, social intelligence, investment in oneself etc.

References

1. Callea, V. (2017, novembre 30). COACH-ING (COACHING-INGEGNERIA) COACHING AND ENGINEERING INTEGRATION. World Engineering Forum 2017 (WEF2017), Rome, Italy. https://doi.org/10.5281/zenodo.8389567
2. Callea, V.: Manuale pratico per comunicare da coach e agire da ingegnere. 1st edn. Edizioni Themis, Italy (2022), ISBN: 9788896069486.
3. Callea, V., Matrisciano, A., Ursache, M., Tempone, R., Chiarotto, I. (2024). COACH_ING Educational Model: Train to Career. In: Auer, M.E., Cukierman, U.R., Vendrell Vidal, E., Tovar Caro, E. (eds) Towards a Hybrid, Flexible and Socially Engaged Higher Education. ICL 2023. Lecture Notes in Networks and Systems, vol 900. Springer, Cham. https://doi.org/10.1007/978-3-031-52667-1_19
4. Spencer, L.M. Jr, Spencer, S.M.: "Competence at Work: Models for Superior Performance". 1st edn. Wiley, United States (1993).
5. Whitmore, J.: "Coaching for Performance: The Principles and Practice of Coaching and Leadership". 5th edn. Nicholas Brealey Publishing, United Kingdom (2017).
6. Angel, P., Amar, P.: "Le Coaching". Presses Universitaires de France, France (2012).
7. V. Callea et al., "Coach ING: From model to tool," 2021 6th International Symposium on Environment-Friendly Energies and Applications (EFEA), Sofia, Bulgaria, 2021, pp. 1-4, doi: 10.1109/EFEA49713.2021.9406254.
8. V. Callea, M. Ursache, I. Chiarotto, A. Matrisciano, R. Tempone, "Integrating personalized educational concepts for enhancing communication skills through the strengthening of related microskills: a case study at University of Rome "Sapienza"", 2024 IEEE Global Engineering Education Conference (EDUCON), Kos, Greece, 2024
9. E. Santini, V. Callea and R. Tempone, "Coach-ing, an Integrated System of Skills: Experimentation and Guided Validation," 2018 5th International Symposium on Environment-Friendly Energies and Applications (EFEA), Rome, Italy, 2018, pp. 1-6, doi: 10.1109/EFEA.2018.8617053.
10. Pujitha, S., Prasad KDV, Y.: "Complete And Competent Engineers: A Coaching Model To Developing Holistic Graduates". In: 5th World Conference on Educational Sciences, pp. 1367 – 1372. WCES - Procedia - Social and Behavioral Sciences 116, Rome (2013).
11. Bettinger, E., Baker, R.: "The Effects of Student Coaching in College: An Evaluation of a Randomized Experiment in Student Mentoring". In: Educational Evaluation and Policy Analysis, pp. 3-19. American Educational Research Association, United States (2011)
12. D. López-Fernández, P. P. Alarcón and E. Tovar, "Assessment and development of transversal competences based on student's autonomous learning," 2016 IEEE Global Engineering Education Conference (EDUCON), Abu Dhabi, United Arab Emirates, 2016, pp. 482-487, doi: 10.1109/EDUCON.2016.7474597.