Approach towards Raising Competencies for a More Successful Education of Engineers

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***Abstract*—The aim of this paper is to get insight into the perception of students regarding the competencies, i.e., skills that are important for successful learning so that textile engineering education can be focused more on the improvement of the level of those competencies. The perception of students is observed at different levels of higher education and the differences are reported. The outcomes of this study pointed out that the emphasis on the skills important for success in learning is placed on methodological skills, especially "results orientation". A conducted focus group research indicated the guidelines that should be used to increase the "results orientation". The guidelines are applied in the curricula with very positive and stimulating outcomes.**

***Keywords*—learning, competency, social, methodological, personal**

I. Introduction

Based on a number of recommendations and initiatives, many educational institutions give great effort to the improvements of teaching in order to assist successful learning. The institutions re-examine the fundamental question of what it means to be educated in the 21st century and restructure programs to meet the needs of future employers. Some of them are experimenting with alternatives designed to enhance successful learning. In all these processes, the main questions that need to be encompassed are:

Which skills and competencies are important for successful learning and future employment?

How can institutions/teachers tailor programs and services to meet student's needs?

Some authors report that an individual's learning orientation, and therefore the approach to learning, is partially determined by personality [1, 2]. Among the "big five" personal factors (extraversion, agreeableness, conscientiousness, neuroticism, and openness to experience), a positive association was found for conscientiousness [2]. According to the Framework for 21st Century Learning, the key elements of 21st Century Learning are both student outcomes and learning support systems. The main student outcomes are defined as life and career skills, learning and innovation skills, and information, media, and technology skills [3]. There has been a significant effort to define all the skills needed for success in learning and work, as well as to group these skills and give recommendations. One of the most cited and used lists is the one provided by The Secretary's Commission on Achieving Necessary Skills [4]. The second useful resource for the list of soft skills is given in the report of the LLP project MODernising Higher Education through Soft Skills Accreditation [5]. The project's final report identifies the most relevant soft skills in higher education. The skills are clustered into three groups: personal, content-reliant/methodological, and social. Although the importance of listed skills is widely accepted, those skills may still not be adequately taught in universities. Research related to improvements in textile engineers' teaching is few. The most appropriate techniques for doctoral research in the field of textile engineering have been selected, and recommendations have been given for their use in doctoral research [6]. The research comprising the opinions of 66 employers from the textile and leather sector ranked the importance of a wide range of transversal skills in success in learning and employment. Social and civic skills, cultural awareness and creative expression, the ability to respect diversity, and communication skills are more sought after in design-related jobs. Psychomotor skills, reaction time, and precision of machine and equipment control are highly rated for engineering jobs [7].

This paper aims to get insight into the perception of students regarding the competencies, i.e., skills that are important for successful learning so that those skills can be improved within the process of textile engineers' education. The perception of students is observed at different levels of higher education and the differences are reported. On the basis of the results and conducted focus group research, guidelines for the improvements of the teaching process are proposed.

II. Methodology

Survey methodology is selected as the most suitable to test the study's objectives, i.e., student's perception of the importance of skills for success in learning in the field of textiles. For the purpose of the research was developed a questionnaire consisted of the following parts:

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(1) Personal information relevant to the survey, and;
(2) Assessment of the level of importance of a single skill for success in learning.

In the first part, related to personal information, students are asked to define their age, gender, school they completed before enrolment at the university, and the module they enrolled in.

The second part is focused on the grading skills that are important for success in learning. The list of skills is prepared according to the recommendations given in LLP project MODes. This includes 20 skills of which 6 are social (communication, user/customer orientation, teamwork, leadership, conflict management, contact network), 7 are methodological (creativity/innovation, decision making, analysis skills, management skills, adaptability to changes, results orientation, continuous improvement) and 7 personal (learning skills, commitment, professional ethics, tolerance to stress, self-awareness, life-balance, cultural adaptivity). A slight change in the definition of skills is made in order to adapt their meaning to the topic of the research.

TABLE I. SOCIO-ECONOMIC INDICATORS

Items	Group 1			Group 2			Group 3		
	Range	**Mean**	**St dev**	**Range**	**Mean**	**St dev**	**Range**	**Mean**	**St dev**
Age	20–33	26.75	6.26	21–25	22.11	1.2	24–26	24.4	1.02
Gender	25% Male 75% Female			11% Male 89% Female			20% Male 80% Female		
Elementary education	0% gymnasium 100% vocational schools			44% gymnasium 56% vocational schools			20% gymnasium 80% vocational schools		

The students are asked to grade the importance of each skill for the success in learning and achievement of excellence in learning process. For the assessment is used Likert scale - a psychometric scale commonly involved in research that employs questionnaires. It is the most widely used approach to scale responses in survey research. In this case is used the format of a typical five-level Likert item (1. Strongly disagree; 2. Disagree; 3. Neither agree nor disagree; 4. Agree; 5. Strongly agree).

The participants in this study are students who attend courses at three different levels of education at the Faculty of Textile Technology. The first group of participants completed high school and attended the second year of professional study. The second group of participants completed high school and attended the last semester of undergraduate study. The third group of participants completed the undergraduate level (Bachelor) and attended the last semester of the graduate program. The socio-economic indicators of participants are given in Table I. The indicators are stated in order to give an insight into the profile of participants and to facilitate comparisons with future investigations related to this topic.

The survey is administrated using the paper-and-pencil self-administered technique. Descriptive statistics is used to summarize the basic features of the obtained set of data.

III. RESULTS OF THE SURVEY AND DISCUSSION

Statistical analysis of data obtained through questionnaires, regarding the perception of the most important skills for learning, is shown in Tables II–IV. Each table brings the results given by a single group of participants.

From the results shown in Tables II–IV, it could be concluded that the emphasis on the skills important for success in learning is, within students of all three groups, given on methodological skills. Those skills are followed by a group of personal skills, while there is a lack of emphasis on the group of social skills. Regarding the methodological group of skills, all three groups of students gave high grades for the skill "results orientation" (mean values of grades are 4.75–4.80). Furthermore, higher grades are also given for "decision making", "continuous improvement" and "creativity/innovation". Among the personal skills, all three groups of students are compliant about the most important one – "commitment" (mean value of grades is above 4.50). The students of professional and undergraduate study placed the "learning skills" in the second position (mean grades 4.50 and 4.67). As said at the beginning, there is a lack of emphasis on social skills and no consistency within the grades given by three groups of students. So, the group of students that attended professional study pointed out "communication" and "conflict management", the group of students that attended graduate study pointed out "teamwork", while the students of undergraduate study gave lower grades for all listed skills within the observed group of skills. In addition to the previous, students consider "leadership" least important for success in learning. The reason for such an attitude should be sought in the fact that there may be a lack of group project tasks in the curricula. Therefore, students don't think that leadership in teamwork or in group learning may have an influence on the learning outcomes. Regarding the least important skills, the group of undergraduate students additionally named all the listed skills within the group except "communication". In accordance with the previously given explanation regarding the lack of group project tasks, the same could be said to explain the low grades for "management skills" that are given by all students. Besides this skill, lower grades are also given for "adaptability to changes". All students consider that "management skills" are the least important for successful learning among all named methodological skills (grades are 2,78 to 3,40). It is interesting to observe that students of professional and undergraduate study don't consider the "life balance" important for successful learning, while students of graduate study consider this skill quite important. It is evident that among the

members of the last-named group of students, who are at a higher level of study, there is a more pronounced awareness of the need to harmonize the obligations in life. Furthermore, lower grades are also given to the importance of "cultural adaptivity". Such a result was expected due to the fact that students of all observed groups study and live in an environment where multiculturalism is not present to a greater extent, so they are not aware of its importance.

TABLE II. DESCRIPTIVE STATISTICS OF GRADES FOR THE PERCEPTION OF IMPORTANT SKILLS – GROUP 1

Skills		Mean	CV	St dev
Social Skills	Communication	4.5	11.11	0.50
	User/Customer orientation	4.25	10.19	0.43
	Teamwork	4.25	10.19	0.43
	Leadership	3.25	33.53	1.09
	Conflict management	4.50	11.11	0.50
	Contact Network	4.75	9.12	0.43
Methodological Skills	Creativity/Innovation	4.50	19.25	0.87
	Decision making	4.75	9.12	0.43
	Analysis skills	4.25	19.51	0.83
	Management skills	3.25	25.51	0.83
	Adaptability to changes	3.75	22.11	0.83
	Results orientation	4.75	9.12	0.43
	Continuous improvement	4.50	11.11	0.50
Personal Skills	Learning skills	4.50	11.11	0.50
	Commitment	4.50	11.11	0.50
	Professional ethics	4.25	10.19	0.43
	Tolerance to stress	4.25	10.19	0.43
	Self-awareness	4.50	11.11	0.50
	Life-balance	3.75	11.55	0.43
	Cultural adaptivity	3.75	22.11	0.83

TABLE III. DESCRIPTIVE STATISTICS OF GRADES FOR THE PERCEPTION OF IMPORTANT SKILLS – GROUP 2

Skills		Mean	CV	St dev
Social Skills	Communication	4.22	24.4	1.03
	User/Customer orientation	3.22	38.09	1.23
	Teamwork	3.67	34.02	1.25
	Leadership	2.33	45.18	1.05
	Conflict management	3.56	26.88	0.96
	Contact Network	3.78	27.28	1.03
Methodological Skills	Creativity/Innovation	3.78	29.99	1.13
	Decision making	4.44	15.41	0.68
	Analysis skills	3.22	28.44	0.92
	Management skills	2.78	32.98	0.92
	Adaptability to changes	3.44	30.94	1.07
	Results orientation	4.78	8.7	0.42
	Continuous improvement	4.56	10.91	0.50
Personal Skills	Learning skills	4.67	14.29	0.67
	Commitment	4.56	10.91	0.50
	Professional ethics	3.67	28.75	1.05
	Tolerance to stress	4.22	29.07	1.23
	Self-awareness	4.11	24.17	0.99
	Life-balance	3.11	31.94	0.99
	Cultural adaptivity	2.44	34.02	0.83

TABLE IV. DESCRIPTIVE STATISTICS OF GRADES FOR THE PERCEPTION OF IMPORTANT SKILLS – GROUP 3

Skills		Mean	CV	St dev
Social Skills	Communication	4.50	11.11	0.50
	User/Customer orientation	4.25	10.19	0.43
	Teamwork	4.25	10.19	0.43
	Leadership	3.25	33.53	1.09
	Conflict management	4.50	11.11	0.50
	Contact Network	4.75	9.12	0.43
Methodological Skills	Creativity/Innovation	4.50	19.25	0.87
	Decision making	4.75	9.12	0.43
	Analysis skills	4.25	19.51	0.83
	Management skills	3.25	25.51	0.83
	Adaptability to changes	3.75	22.11	0.83
	Results orientation	4.75	9.12	0.43
	Continuous improvement	4.50	11.11	0.50
Personal Skills	Learning skills	4.50	11.11	0.50
	Commitment	4.50	11.11	0.50
	Professional ethics	4.25	10.19	0.43
	Tolerance to stress	4.25	10.19	0.43
	Self-awareness	4.50	11.11	0.50
	Life-balance	3.75	11.55	0.43
	Cultural adaptivity	3.75	22.11	0.83

IV. FOCUS GROUP RESEARCH: "RESULTS ORIENTATION"

The results of the survey indicated that students of all three groups consider "results orientation" as the most important skill for successful learning. After this skill is defined, the following step was to get direct feedback from the students on the question: "How can this skill be improved and how can a teacher contribute?".

In order to get direct feedback, focus group research is chosen because it helps to gain substantial insights into a variety of issues from the macro level to a very detailed level. For the group of recruited students who showed special motivation for the discussion about this topic during the survey. Participants are informed about the purpose and design of the research, as well as the ground rules for the conducting of a focus group. The participants are assured that there will be privacy in gathering, storing, and handling data. Participants are asked to express what they think and feel, without repercussions, as well as to speak individually and not over each other. The discussion within the group was free-flowing.

The transcript of the session is used for the discussion of the outcomes of conducted focus group research. The guidelines defined within the focus group on how to improve "results orientation" are as follows:

- HOW 1 – To design long-term goals based on a broad vision of what is possible

The teacher may help students to realize which goal is their ultimate and how to reach it. The state is possible through the mentoring program when the interaction between teacher and student is one-to-one. During the teaching process, the teacher can give positive examples from their own practice, as well as describe solutions that were applied by former students.

- HOW 2 – To maintain teamwork and team building

Teachers may include in their teaching process more assignments that need to be resolved in teams. If necessary, the teacher should help to resolve possible conflicts between the members of the group, and raise their awareness about the benefits of teamwork.

- HOW 3 – Progress feedback

Feedback on progress in learning may be included, because it is to expect that new practices should be accepted and retained if they are perceived as effective. Teachers may conduct regular checks on students in the form of different assessments (tasks, demonstrations, projects, etc.) that are later paired and discussed.

V. Application of Outcomes in the Teaching Process

In order to increase the "results orientation" among students in the educational process, significant efforts or authors of this paper are given to focus on three defined "HOWs". The courses they teach are structured in a way to include more assignments that have to be resolved in teams. Teachers continuously reminded students of the main goals and positive examples, and gave significant support during teamwork. The progress in learning, as well as resolving results, are monitored and evaluated both by students and teachers. From the comparison of the evaluation results before the start of actions and later, a significant increase in satisfaction among students is well seen. Students reported a rise in awareness regarding the goals they have to achieve, an increase in positive attitude towards learning, as well as increase in willingness to perform additional tasks at home (even when those tasks are optional). Teachers reported an increase in the readiness of students to perform tasks and a very positive attitude towards the acquisition of knowledge. Considering the results of the investigation, the authors of this paper plan to continue the process of improvements by considering the actions that may raise additional skills that are defined as important – "decision-making" and "commitment". They intend to use the same methodological approach to define needed actions, as described in this paper. The guidelines on how to improve "results orientation" may appear obvious, but it also may be rare to find a teacher who implemented them into the teaching process or is aware of the implementation. Furthermore, it is even rarer to find teachers who evaluate the implementation of guidelines. In an ideal case, the teacher should find an optimal mix of effective practices and try to implement them in order to assist successful learning. The investigation reported in this paper focuses on a single skill, but each teacher should define preferred skills and try to make a breakthrough in the teaching process.

VI. Conclusion

The importance of skills for success in learning is recognized, but in many educational institutions, skills still do not have a proper place in curricula. Furthermore, skills that complement subject-specific knowledge are today commonly demanded by employers and therefore represent an important factor in increasing students' employability. The outcomes of this study pointed out the following issues:

- Emphasis on the skills important for success in learning is for students enrolled at different levels of education, placed on methodological skills, especially "results orientation";
- Among the personal skills, all three groups of students are compliant about the most important one and that is "commitment";
- There is a lack of emphasis on social skills and no consistency within the grades;
- Students consider "leadership" least important for success in learning.

After the main skills that influence successful learning are defined, teachers should find an optimal mix of effective practices and adapt them in response to a variety of influences.

Conflict of Interest

The authors declare no conflict of interest.

Author Contributions

ISČ and GČ conducted the research and analyzed the data; ISČ, GČ, and VMPM wrote the paper; all authors had approved the final version.

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