

mipro 2020

ISSN 1847-3946

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MIPRO 2020

43rd International Convention

September 28, 2020 – October 2, 2020
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All papers are published in their original form

For Publisher:

Karolj Skala

Publisher:

Croatian Society for Information, Communication and
Electronic Technology – MIPRO
Office: Kružna 8/II, P. O. Box 303, HR-51001 Rijeka, Croatia
Phone/Fax: (+385) 51 423 984

Printed by:

GRAFIK, Rijeka

ISSN 1847-3946

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Effective Decision Making: the Added Value of Including Humanities in STEM Studies

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Abstract - The rapid ascension of STEM programs in education came accordingly with the needs of the labour market. Although technology made its way into our everyday lives, it is difficult to find a balance between the empowerment it brought by making our everyday tasks easier and our dependency on it that came with it. In search of that balance, there is a vast need in the contemporary digital revolution for computer engineers to be able to make responsible political, ethical and social decisions while contributing to the global economy and the future of the world. Besides technical skills they learn as a part of their curriculum, STEM students and experts in the field need decision making skills for their personal and professional development. The importance of implementing courses from the field of humanities in education has been recognized by educators and employers. The aim of this research is to determine whether the students themselves are aware of the added value such courses could bring to them which will be presented in this paper on the example of Algebra University College students. The research was conducted through a voluntary Google Forms survey comprised of 10 questions that have shown that students are not fully aware of the added value of including humanities in STEM studies, however, they do believe that learning about effective decision making during their studies would be of benefit to their professional development.

Keywords – *humanities, effective decision making, added value, STEM students, soft skills*

I. INTRODUCTION

The high numbers in Internet usage are just one out of many arguments that prove not only how dependent we are on technology, but also explain the reason of a large increase in STEM field study programs and job vacancies. However, the switch to STEM focused education and employment has brought to question the place of humanities in the higher education curriculum. On the topic of humanities vs. STEM it is always our concern how to best educate ourselves, our children and our students to be able to acclimate to the current ever-changing world of technology. Moreover, it is on us to be able to make correct and effective decisions in our future lives and careers and share that knowledge to those who will join the demanding and fast changing labour market. Technical skills that STEM students are taught in their education provide them with the knowledge to become trained professionals in the field of their interest and apply that knowledge to their job positions. Nevertheless, that is not a guarantee that a person will succeed. The job market is highly competitive, and students require a well-

rounded education in order to become attractive to employers and be successful in their field. Making decisions in their professional path will become an everyday challenge for the future IT experts and it is up to educators to prepare them to be able to bring responsible decisions with positive outcomes. The lack of non-technical skills in STEM students has been widely recognized by employers, however, the challenge is to determine whether the students themselves see the added value of learning non-technical skills as a part of their curriculum.

II. EFFECTIVE DECISION MAKING: TOP SKILLS FOR SUCCESS

A. Labour market needs

Many researchers have already explored the importance of soft skills in the 21st century by analyzing current labour market trends that show a vast need for university graduates to bring more than the technical skills acquired during their studies. For instance, an employer survey by the OECD concluded that job specific skills are no longer enough for graduates to meet the needs of the current labour market [1]. Furthermore, a research made by the American Management Association showed that “soft skills” such as critical thinking, decision making and problem solving, creativity and innovation, collaboration and communication are becoming increasingly important in the current global economy [2]. Moreover, the Wall Street Journal survey in 2015 reported that out of nearly 900 executives last year, 92% said soft skills were equally important or more important than technical skills. However, 89% said they have a very or somewhat difficult time finding people with the necessary competences [3].

STEM degrees have increased in numbers in the past decade, arguably due to the needs of the current labour market that lacks professionals skilled in STEM fields. A report by the European Parliament on overview of the labour market situation in STEM occupations showed that STEM skilled labour is increasing and is expected to grow even more. The number of STEM university graduates has increased in 15 EU Member States and in entire Europe since the mid-2000s. Employment in STEM-related sectors is predicted to grow by 6.5 % between 2013 and 2025, from which a growth of 8 % is expected in computing sector [4]. Pursuing a degree or a position in the STEM field requires technical skills and knowledge and universities have been focusing on

checking off boxes that equip their students with the right set of skills for that field. However, schools, businesses, and community leaders have recently started to realize that technical skills alone are not sufficient for the competitive and fast-paced STEM field. People with outstanding technical skills may be able to deliver in a familiar environment, but it is not enough for them to become top of their field. Whether they are trying to move up or are required to be on a cross-functional team, soft skills are needed by every STEM professional to compliment the hard skills.

B. *Soft and people skills*

The terms “hard” and “soft” skills often come up in the employment industry as vital requirements of the current labour market. Hard skills, or technical skills, are defined as “those skills acquired through training and education or learned on the job and are specific to each work setting, such as programming languages, operating system skills, networks and communications, etc. [5]. On the other hand, “soft skills” are defined as “the cluster of personality traits, social graces, language skills, friendliness, and optimism that mark each one of us to varying degrees” [6]. Non-technical, or “soft skills” are often recognized in the industry by other terms, such as “people skills”, “emotional skills”, “employment skills” etc. The Higher Education Council of Australia defines soft skills as “the skills, personal attributes and values which should be acquired by all graduates, regardless of their discipline or field of study” [7]. More abstractly, some researchers point out that soft skills are interpersonal, human, people or behavioural skills needed to apply technical skills and knowledge in the workplace [8]. The Assessment and Teaching of 21st Century Skills (ATC 21) organization has presented a framework for organizing different types of 21st century skills. It includes four classes of soft and hard skills:

1. Ways of Thinking, which encompasses creativity and innovation; critical thinking, problem solving, and decision-making; and metacognition or learning to learn
2. Ways of Working, which includes communication and collaboration or teamwork
3. Tools for Working, which addresses information literacy and information and communication technology (ICT) literacy
4. Living in the World, which includes citizenship, life and career skills, and personal and social responsibility [9].

Conversely from “hard skills” that are job specific, soft skills are transferable between learning and work settings. For example, a Software Engineer can transfer his problem solving and decision making skills from his or her role in one industry to the other. However, the person would need to adapt those skills to the current work setting. The problem solving and decision making skills stay the same, but the context in which they are applied is different, so when developing these skills for

students it is important for the teaching process to be diverse, so that the transferring of the “soft skills” across different contexts would be easier.

C. *Effective decision making*

As one of those skills, effective decision making (often in research synonymous with problem solving) became a crucial skill for students to develop in order to become a better skilled worker for the current job market. We can define effective decision making as a process that facilitates our intellectual, moral and spiritual decision-making and helps us determine the simplest and most efficient way to make the right decision.

The decision making process is an important skill for employers as it saves them time and money by hiring individuals with this skill as they can effectively plan and organize their team by following a structured process instead of relying solely on their intuition without taking the time to analyze the possible outcomes of their decision. University of Massachusetts divided this process into 7 steps:

1. IDENTIFYING THE DECISION – Defining the nature of the decision
2. GATHERING RELEVANT INFORMATION – Collecting information from the best sources available depending on the decision
3. IDENTIFYING ALTERNATIVES – Identifying several possible paths of action and listing all possible alternatives
4. WEIGHING THE EVIDENCE – Drawing on information collected and imagining of each alternative listed. Through this step you can place the alternatives in the order of priority, based upon your own value system
5. CHOOSING AMONG ALTERNATIVES – selecting the alternative that is the best one for you, or a combination of alternatives.
6. TAKING ACTION – Starting to take some positive action and implementing the alternative chosen in step 5.
7. REVIEWING YOUR DECISION & ITS CONSEQUENCES – considering the results of your decision and evaluating whether it resolved the problem you identified in step one [10].

Following this process helps us make a decision that is more thought out than just relying on our instincts and assuming that a certain decision will bring positive results. Instead, a structured process can help an individual and in the end the business to experience positive outcomes from making a right decision. However, as many other “soft skills”, effective decision making has to be acquired by students during their university education so they can finish their studies fully prepared for what the current market demands. The only way to accomplish such goal is to include subjects from various academic disciplines into the STEM curriculum.

III. THE ADDED VALUE OF HUMANITIES

The Stanford University Humanities Center defines humanities as “the study of how people process and document the human experience,” going on to explain that “since humans have been able, we have used philosophy, literature, religion, art, music, history and language to understand and record our world” [11]. The word humanities derives from the Latin word *humanus* (humanity), which comes from the word *homo* (human). The humanities deal with man, morality and ethics, man's thirst for knowledge, love of wisdom, culture, languages, history and art. Therefore, courses in the humanities concern, for example, anthropology, philosophy, ethics, theology, history, art history, and the science of art.

There are many layers to humanities, and they are more than merely a study of human culture. Humanities help us think critically and creatively, think about “why” of the problem and connect the dots to get an answer to the “why” question. Deborah K. Fitzgerald, a professor of History of Technology at MIT stated that by including humanities in their studies, students learn that “most human situations defy a single correct answer, that life itself is rarely, if ever, as precise as a math problem, as clear as an elegant equation” [12]. Moreover, she continues, students “gain historical and cultural perspectives, and critical thinking skills that help them collaborate with people across the globe, as well as communication skills that enable them to listen, explain, and inspire”.

In education, humanities enhance our moral beliefs and often make us question the arguments and situations beyond our own understanding. These skills are equally important for STEM students. In order to be truly innovative, scientists must consider how their work will affect the world and its inhabitants [13].

In the past, humanities were deemed as pillars of our society and were principal in higher education. Philosophy, ethics, literature and languages dominated the higher education industry and education in humanities was what created a Renaissance man. However, the shift to a technology focused world and STEM focused education has challenged the position of humanities in higher education. Nevertheless, there is a reason why humanities reigned the world of higher education before the appearance of technology and why they should still be included in the curriculum of STEM students. As humanities are a broad term and subjects in the field are numerous, the higher education industry has to create a suitable interdisciplinary study of humanities in cooperation with the job industry to make sure students receive education from the field of humanities that will add value to their education and create a complete, job market ready graduate. Arguably, there is no need for a Software or System Engineer to necessarily study in depth all subjects that make up humanities. There is no added value to his studies if the universities fill up the already crowded STEM curriculum with courses such as poetry, archeology or history of arts. The added value that is referred to in this context is the addition, or the benefit

a student will have from a certain course in the field of humanities for his further professional or personal development. In addition, if we examine all of the disciplines that comprise the field of humanities, on the surface, we will find very few that add value to the future career of a Software Engineer. So how can we determine which humanities disciplines add value to a STEM curriculum?

By staying on top of current trends in the employment industry. Universities have a great responsibility to respond to the criticisms of the employment industry that students are not equipped with the skills of the 21st century, that is, the above-mentioned “soft skills”. Even though seemingly not a discipline in humanities, soft skills originate from all of the disciplines in the field of humanities. The soft skills that emerged from humanities can help give us answers on some of the most complex questions and problems in science and technology. Studies within humanities teach students to evaluate complex and sometimes flawed or fragmentary information by skeptically and carefully considering evidence and considering more than one side of every question. By comparing information with different points of view and using critical and creative thinking, students are taught to make a subjective and effective decision, which is one of the key skills of the 21st century job market. To be able to make the right decision for your problem, you need to use other “soft skills” that are a part of the decision making process. Such skills do not come to an individual naturally, and by creating a curriculum that will allow students to gain these humanities based skills we are preparing them for success.

IV. STEM STUDIES CURRICULUM: FUTURE CHALLENGES

STEM studies curriculum will surely have to adapt to the dissatisfaction of the job industry with the level of soft skills STEM students bring to the industry. STEAM was in its way a response to the demands of the industry and has successfully tackled one of many challenges the higher education sector faced. Adding Arts to the already stone set Science, Technology, Engineering, and Mathematics world opened up an array of possibilities for students interested in those four disciplines to acquire skills from the field of arts. Nevertheless, there are more challenges that universities will face, some of which are:

1. LACK OF RESEARCH – the current state of STEM curriculum in regards to the representation of humanities is important to determine, as it is the foundation to understanding and responding to other challenges that the higher education industry will have to surpass. Not much research has been made on the statistical representation of non-technical courses in the STEM curriculum. In order to establish a well-rounded curriculum, the universities will require past research to help them with the process.

2. **MOTIVATING STUDENTS** – for some students it is difficult to see the added value of something that they do not fully understand and that is not a requirement of the profession. It will be challenging to motivate students to see the importance of developing their effective decision making skills for their personal and professional development.
3. **INCLUDING HUMANITIES IN THE CURRICULUM** – with the curriculum already being extensive, it will be demanding to find a form and space for the humanities skills. Universities can choose many options, such as the development of soft skills through stand-alone subjects or by embedding it in existing courses.
4. **PLANNING ACTIVITIES** – skills such as effective decision making require a dynamic and practical approach to be used to its full potential. That requires educators to be creative and think carefully about the activities they can present to students that will keep them motivated and help them learn the effective decision making process.
5. **KEEPING TRACK OF THE INDUSTRY** – the process of changing a curriculum of a study program does not happen over night. There are many factors to consider that differ from university to university and from country to country. Making those changes is an administrative and sometimes slow process so the challenge will be for universities to keep up with the demands of the labour market.

V. THE RESEARCH METHODOLOGY

A. Research Objectives and Methods

The main research objective was to examine and determine do Algebra University College STEM students realize the added value of effective decision making as the part of their curriculum.

The research was conducted through a voluntary Google Forms survey during the winter semester of the 2019/2020 academic year. The survey was anonymous and consisted of 10 questions, 4 of which refer to demographics. For 6 questions answers were predefined with the 5 degrees of importance according to the Likert scale. A quantitative method was used for the analysis of the research results and the results were processed by Microsoft Excel tool.

B. The Research Sample

The research was conducted among Algebra University College students in STEM studies.

The total number of population sample was 60, N = 60. The majority of participants are Software Engineering students (57 %), while other students who participated come from System Engineering (23%), Multimedia Computing (13%) and Game Development (7%) study programs.

The majority of participants were undergraduate students; 90 % of them, while 10 % of participants were graduate students. More than 80 % students were male students. The structure of all surveyed students according to the study program, level of study and gender is presented in Table.1

Study Program	Software Engineering	System Engineering	Multimedia Computing	Game Development
Number of students	34	14	8	4
Gender				
Male	32	9	6	4
Female	2	5	2	0
Study level				
Graduate	2	1	3	4
Undergraduate	32	13	5	0

Table 1. The structure of the participants by Study Program. N=60

C. The Research Results

The research objective was examined through the research questions. In order to answer the research objective, 3 research questions were asked:

1. *Do and to what extent Algebra University College STEM students realize the added value of including courses from the field of humanities in their STEM curriculum?*
2. *Do the STEM students think that soft skills will benefit them in their professional development?*
3. *Do the STEM students think that learning about effective decision making is important for their professional development?*

In order to answer the first research questions, the questions asked in the survey were as follows:

1. *Do students find that the courses from the humanities field are represented enough in their curriculum?*

The research results have shown that only 2% of the total number of surveyed students finds courses from the humanities field very important for their curriculum. Conversely, 37 % of students believe that such courses are not important. Distribution of the answers for the importance of humanities courses in the curriculum can be found in Chart 1.

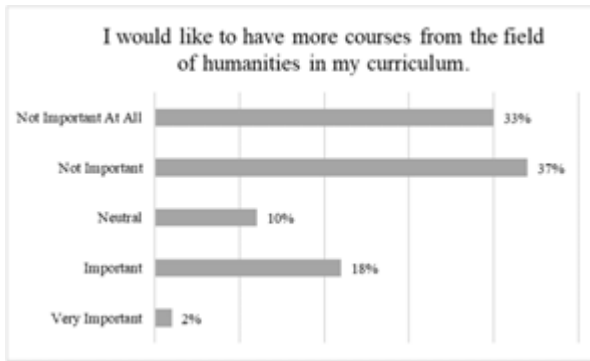


Chart 1. Distribution of the answers to the question: *How important do you find the inclusion of courses from the field of humanities in your curriculum?* N=60

2. *Do students wish they had more courses from the field of humanities in their curriculum?*

20% of the students expressed the wish to study more humanities based courses, while almost 40% of the students see no need in learning more humanities courses than they do. Furthermore, 10 % remained neutral. Chart 2. presents answers of participants to the above mentioned question.

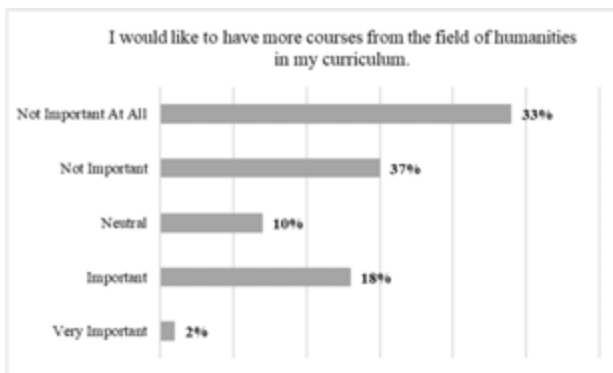


Chart 2. Distribution of the answers to the question: *Would you like to have more courses from the field of humanities in your curriculum?* N=60

In order to answer the second research question, the questions asked in the survey were as follows:

1. *How important do students find courses from the field of humanities for their professional development?*

For 18 % of participants the courses in humanities are important for their professional development, while 25 % of students believe they are not. Moreover, 22% of students remained neutral to this question and while 25 % of students find courses from humanities not important at all for their professional development, and 10 % very important. Distribution of the answers on whether the students consider courses in humanities relevant for their professional development is presented in Chart 4.

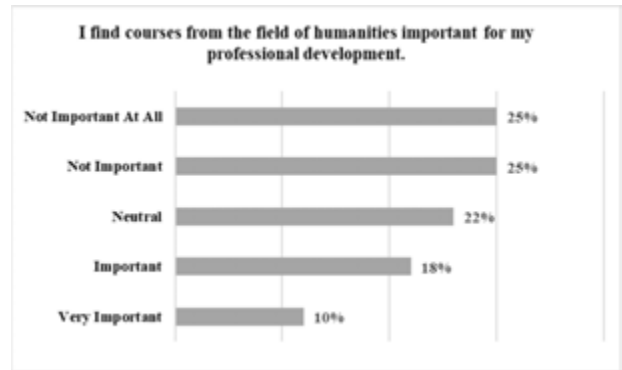


Chart 4. Distribution of the answers to the question: *How important do you find courses from the field of humanities for your personal development?*

2. *What factors do students find most valuable when looking for a job?*

Students were presented with four different skills and knowledges that could help them find a job: their degrees, technical skills and knowledges, soft skills and connections with the professionals in the field. Presented with the Likert scale of importance they had to choose how valuable they find each of those skills on the scale of 1 to 5 (1 = Not important At All, 2 =Not Important, 3 = Neutral, 4 = Important, and 5 = Very Important). Nearly 80% of students found technical skills and knowledges (in case of STEM studies that are skills such as algorithms, data structures, working with databases, etc.) very important in finding a job and 35% of the students found soft skills very important for their job search. 5% of the students found that their degree and their soft skills are not relevant to their job search.

<i>Important skills in job search:</i>	5	4	3	2	1
Degree	30%	33%	17%	15%	5%
Technical skills and knowledges	77%	17%	5%	2%	0%
Soft Skills	35%	45%	10%	5%	5%
Connections from the field of interest	23%	22%	12%	3%	0%

Table 2. How important do you find the following when applying for a job? N=60

3. *What skills do students find the most important for their professional development?*

Students were presented with 9 different skills and asked to rate the skills from most to least important in regards to their professional development. Presented with the Likert scale of importance they had to choose how valuable they find each of those skills on the scale of 1 to 5 (1 = Not important At All, 2 =Not Important, 3 = Neutral, 4 = Important, and 5 = Very Important). Almost

half of the students rated all skills as very important. Communication skills were rated as very important with 27 students ranking them the highest. Teamwork, business communication and leadership skills followed with 45% of students rating them as very important. Conversely, conflict resolution skills, business ethics skills and business communication skills were rated not at all important by 5% of students.

<i>Skills important for professional development:</i>	5	4	3	2	1
Teamwork skills	45%	37%	12%	3%	3%
Communication skills	55%	35%	5%	3%	2%
Presentation skills	40%	33%	13%	12%	2%
Conflict Resolution skills	43%	30%	13%	8%	5%
Business ethics skills	37%	30%	15%	13%	5%
Negotiation skills	40%	42%	10%	5%	3%
Business communication skills	45%	30%	10%	10%	5%
Leadership skills	45%	30%	13%	8%	3%
People skills	40%	35%	15%	7%	3%

Table 3. How important do you find the following skills for your professional development?

In order to answer the send research questions, the questions asked in the survey were as follows:

1. How important do students think learning about effective decision making would be for their professional development?

The majority of the students found that learning about the process of effective decision making would be important for their professional development. 37 students found learning about effective decision making either very important, or important. 17% of students found that learning about effective decision making would not help their professional development.

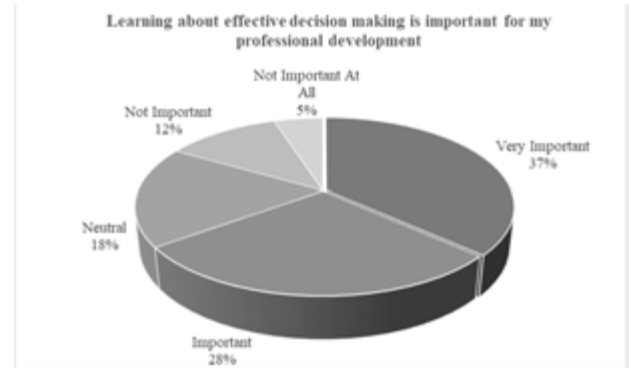


Chart 4. Distribution of the answers to the question: How important do you think learning about effective decision making would be for your professional development?

VI. CONCLUSION

The research has shown that students are not fully aware of the added value of including humanities in STEM studies, however, they believe that learning about effective decision making during their studies would be of benefit to their professional development. Effective decision making is an important process included in all aspects of humanities and soft skills, therefore students realize that it is a skills worthy of learning. Furthermore, there is not enough research on the number of courses from the field of humanities in the STEM curriculum, which makes it more difficult for researchers and educators to determine how much change is needed in the STEM curriculum in regards to humanities. Future generations of students will have to make important moral and intellectual decisions for their entire career and it is important to equip them with the necessary skills to do so. Even though the students may not realize the added value of humanities in their curriculum, it is up to employers to highlight the importance of soft skills for future graduates and, and it is up to educators to make sure that the curriculum is always up to date with the current labour market. Further research can be made on this topic, starting with analyzing the number of courses from the field of humanities in Higher Education institutions which will be a starting point for solving the challenges of STEM studies curriculum.

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