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Online Teaching – Analysis and Solutions Instrumented by Quality Engineering Methods

Irina-Virginia DRĂGULĂNESCU[1*], Gabriela ȚIGU[2], Narcisa VALTER[3], Mihaela Cornelia SANDU[4]

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Abstract

Under current conditions, due to an unprecedented coronavirus pandemic, COVID-19, since the beginning of 2020, online education has become compulsory in most countries of the world. Classical face-to-face education has completely moved into the online environment, becoming distance learning. In this case, the danger of declining student performance is very high, especially in terms of the possibility of exam fraud. Our goal is to decipher the strengths but also the sensitive points of online education, from the student's point of view. To achieve the results, we used the tools and methodologies provided by Quality Engineering. These tools help clarify the issue, identify the most damaging trends, and design prevention methods. The main analysis tools of our research were: statistical evaluation of the answers provided by the students, SWOT analysis, Interrelationship Diagram and Quality Function Deployment diagram (QFD). The case studies concern the university environment, more precisely, the students of the Politehnica University of Bucharest and of the University of Bucharest.

Keywords: online university education, quality engineering tools, student performance, avoid fraud, false values.

JEL Classification: A20; C18; H12; H84; I23; O21; O35.

1. Introduction

It is important to distinguish between normal e-learning and emergency e-learning developed quickly and with the bare minimum of resources and little time due to the COVID-19 pandemic. Thus, the education of about 900 million students in the world was compromised: universities closed, Erasmus programs, and even

[1] University of Bucharest, Bucharest, Romania, irina.dragulanescu@faa.unibuc.ro.
[2] Bucharest University of Economic Studies, Bucharest, Romania, gabriela.tigu@ase.ro.
[3] Politehnica University of Bucharest, Bucharest, Romania, narcisa.valter@upb.ro.
[4] University of Bucharest, Bucharest, Romania, mihaela9sandu@yahoo.com.
* Corresponding author.

exams and graduation sessions suspended. Universities have experienced in a very short time a very strong digital acceleration of their teaching processes, and certainly this can be seen as an added value, even when returning to university classrooms for frontal lessons. To interact with colleagues and teachers it is necessary to have a sufficiently stable internet connection and often the geographical configuration represents a limit. Among the reasons that push students to choose a particular university are: the right course, the availability of computers, the quality of the library facilities, the good reputation of teaching, the availability of "quiet" areas for self-study, and the friendly attitude toward students. A good educational alternative can be a blended mode, in which it is possible to alternate face-to-face activities with others online. After all, what matters is the teacher-student educational relationship, the love and the passion that the teacher is able to transmit in teaching, the students' ability to learn by falling in love with knowledge. This is what makes the difference between a good education and a teaching given only for official duty.

2. Problem Statement

The main factors that contribute to student satisfaction in online courses (Bollinger, 2004) are: teacher performance, communication, technology, course management, educational platforms, and interactivity. Student satisfaction must be at the heart of any teaching method and indicates whether the information and knowledge learned meet student expectations. According to Oduma et al. (2019), e-learning can help universities increase student satisfaction, even if face-to-face learning is perceived as more satisfying. However, online courses present a number of challenges: distance learners may never have visited the physical campus location, and may have difficulty establishing relationships with teachers and other students, etc. Scholars' views on online and conventional learning are contradictory. According to Fortune, Shifflett and Sibley (2006) there is lower overall satisfaction with online courses, Artz (2011) considers student satisfaction higher in attending online courses, while Lin et al. (2019) agree that there is no difference in student satisfaction between conventional and online courses. While Platt, Raile and Yu (2014) pointed out that students do not find online courses equivalent to traditional lessons, perceiving online courses as easier, Bali and Liu (2018), highlight that online learning is also somehow beneficial, even if perceived as lacking in social interaction and communication.

3. Research Questions / Aims of the Research

Our paper concerns the reality of Romania with an increasingly common culture suited to mass universities. Compared to innovative teaching experiences of other countries that already experiment with models based on the use of metaverse, Romania, due to its economic and social conditions, cannot in a short time take different paths from those currently in force. So, this contribution aims to deepen and interpret the experience lived by Romanian university students in the field of distance learning, in order to formulate some proposals to improve the sensitive

aspects of online teaching in a context of transformation and innovation of Higher Education.

4. Research Methods

We use statistical tools for analyzing the results collected from students through online questionnaires and managerial tools and methodologies provided by Quality Engineering. These tools allow clarifying the issue, sorting out the most harmful trends, and designing prevention methods. So, we use the following analysis tools: SWOT analysis, Interrelationship Diagram and Quality Function Deployment diagram (QFD). To determine the perception of students about online classes during the COVID-19 pandemic we developed a questionnaire of 20 questions. Questions have simple, multiple, Likert scale (1 = strongly disagree, 5 = strongly agree) or open answers. The questionnaire was distributed online on social networks to students from University of Bucharest (UB) and University Politehnica of Bucharest (UPB). The respondents to the questionnaire are mainly from the Faculty of Aerospace Engineering with about 1200 students from the Polytechnic University of Bucharest and from the Faculty of Administration and Business with about 2800 students from the University of Bucharest, where the authors of this research are tenured professors. The sample was formed of 462 respondents. Using SPSS, we performed an exploratory analysis of the questionnaire and tested some hypotheses.

5. Findings

The core purpose of our paper was to detect the problems met during the lockdown related to university teaching in undergraduate courses with technical direction from the Polytechnic of Bucharest (UPB) and humanities degree courses at the University of Bucharest (UB).

5.1 Exploratory Analysis of the Questionnaire

Most of the respondents, 73.1%, were female. About 94% of the respondents were 19-25 years old and almost 71% were from the urban area.

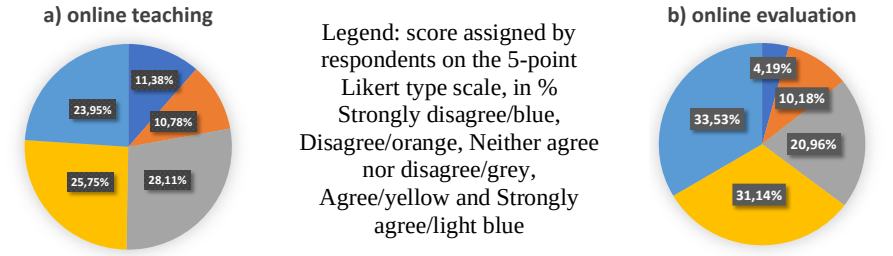
The online platforms used for online classes are: Moodle 28.7%, Zoom 15%, Google Classroom 13.2%, Microsoft Team 9.6%. In terms of teaching methods used during online classes, 70.7% said classical teaching using PPT, 13.2% video classes (voice over PPT), and 13.8% interactive teaching methods. The most used evaluation method was Google forms, 52.1%, followed by Microsoft forms, 26.3%, and Moodle, 7.2%. We had an open-ended question about why students trust or not the evaluation method. The majority, 89.2%, said they trust the professor so they trust the assessment method, many students said they liked getting the results instantly, and they are also confident that for multiple choice test the platform used in evaluation cannot make a mistake. Among those who did not trust the evaluation method, the majority said that the time for exam was not enough because the professors were afraid the students will cheat during the exam; also, the students said that during the online evaluation it is easier to cheat on the exam. Comparing the

responses received from students from UB and UPB for confidence in online evaluation, 9.09% students from UB and 20.83% students from UPB said they don't trust online evaluating methods.

In terms of problems encountered in online teaching, 43.7% declared internet connection, 30.5% the lack of motivation, 7.2% the poor ability to use online platforms. Most of the students said that the main advantage of online teaching is access to classes from the comfort of their home, 38.9%, so 29.3% do not waste time on their way to the faculty, 20.4% can do other activities during the online classes and 5.4% do not have to pay the rent. In terms of disadvantages of online classes, 44.3% declared lack of interaction with professors and colleagues, 24% direct communication with the professor and colleagues, 13.2% time spent in front of the computer, 5.4% loneliness, and 4.8% lack of practical application in the laboratory.

Figure 1 (a), shows student's perception of online classes and online evaluation. In the case of online classes, 28.14% of students prefer online and traditional classes alike, 25.75% prefer online classes more and 23.95% strongly agree that they prefer online classes more.

Figure 1. Student's perception about online teaching and evaluation

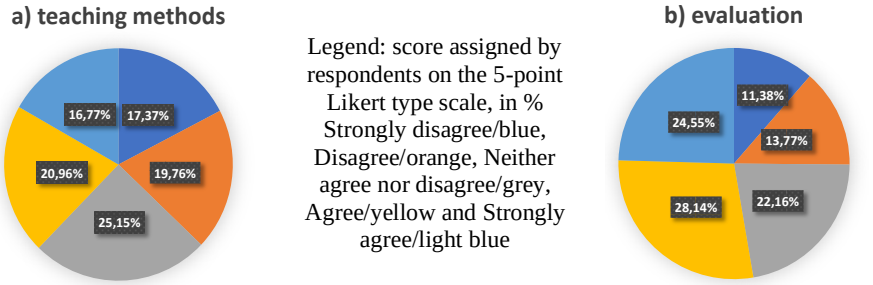


Source: The authors' own research based on the questionnaire.

In case of online evaluation, Figure 1 (b), 20.96% of students prefer the online and traditional evaluation equally, 31.14% said they agree they prefer online evaluation more, and 33.53% strongly agree they prefer online classes more.

In terms of efficiency of online classes compared to traditional ones (Figure 2), 16.77% said they strongly agree and 20.96% agree that online classes are more efficient. On the online evaluation compared to the traditional one, 24.55% said they strongly agree and 28.14% agree they strongly agree that online evaluation is more efficient than the traditional one. In case of an option to choose online classes and online evaluation in the future, 40.12% said they strongly agree, and 25.75% agreed they would prefer to choose online classes. Regarding the online evaluation compared to the traditional one, 20.96% agree and 16.77% strongly agree that they will choose online evaluation if possible in the future; nearly a quarter of students, 25.15% said they did not see any difference between these two types of evaluation. As for the overall perception on the attending online courses, 51.50% said it was rather positive and 14.37% said it was rather negative.

Figure 2. Efficiency of teaching methods and evaluation in case of online classes



Source: The authors' own research based on the questionnaire.

5.2 Hypotheses Testing

In this part of the paper we tested some hypotheses to see if there is any difference of opinion between the UB and UPB students about online classes and evaluation. The hypotheses tested for this purpose are the following:

H0a Compared to UPB' students, UB' students prefer online courses to traditional ones
H1a Compared to UPB' students, UB' students don't prefer online courses to traditional ones
H0b Compared to UPB' students, UB' students prefer online evaluation to traditional one
H1b Compared to UPB' students, UB' students don't prefer online evaluation to traditional one
H0c Compared to UPB' students, UB' students think that online teaching is more efficient than traditional teaching
H1c Compared to UPB' students, UB' students don't think that online teaching is more efficient than traditional teaching
H0d Compared to UPB' students, UB' students think that online evaluation is more efficient than traditional evaluation
H1d Compared to UPB' students, UB' students don't think that online evaluation is more efficient than traditional evaluation
H0e Compared to UPB' students, UB' students would like possibility to have online classes in the future
H1e Compared to UPB' students, UB' students wouldn't like to have the possibility to obtain to online classes in the future
H0f Compared to UPB' students, UB' students would like possibility to have online evaluation in the future
H1f Compared to UPB' students, UB' students wouldn't like possibility to have online evaluation in the future

In this case with two populations, students from UB and UPB, we applied a t-test. If the p-value is less than the significant level 0.05 we will reject the null hypothesis. The results of this test are shown in Table 1. After applying the t-test, we obtained the following: compared to UPB' students, UB' students don't prefer online courses to traditional ones but prefer online evaluation to traditional one; compared to UPB' students, UB' students consider that online teaching and evaluation is more efficient

than traditional ones; compared to UPB' students, UB' students would not like to get an online classes in the future, but would like to get online evaluation in the future.

Table 1. Results for t-test used for hypothesis testing

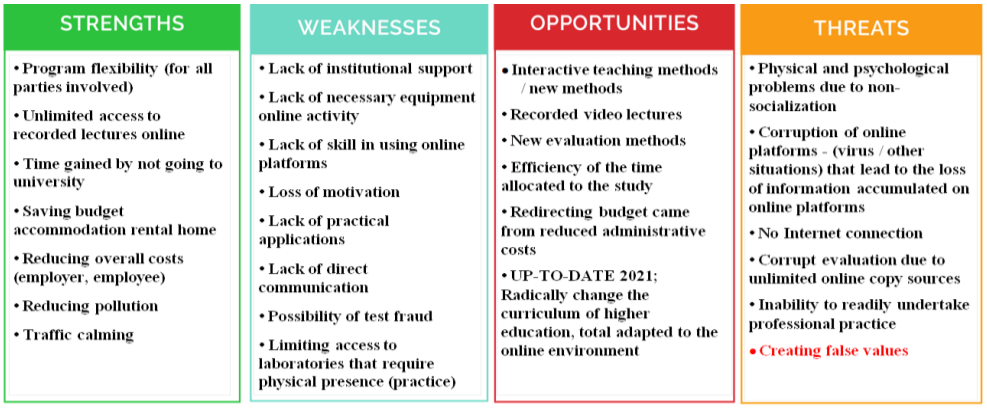
Hypothesis	Mean in case of online teaching/ evaluation	Mean in case of traditional teaching/ evaluation	t-statistic	p-value	Null hypothesis is accepted
H0a	3.30	4	-2.52	0.012	False
H0b	3.37	3.87	-0.36	0.716	True
H0c	2.92	3.45	-1.82	0.069	True
H0d	3.40	3.41	-0.03	0.969	True
H0e	3.53	4.29	-2.69	0.007	False
H0f	3.82	4.12	-1.14	0.252	True

Source: The authors' elaboration.

5.3 Online Teaching: Pros and Cons from the Teachers' Side using SWOT Analysis

Our analysis regarding the period of pandemic, in which we had to teach and test exclusively online, was performed by us-teachers from UPB and UB to analyze the concrete situation encountered. In Figure 4 we built a SWOT analysis in which we highlighted the most important pros and cons from the point of view of teachers. According to Figure 3, we can consider as pro-online categories "Strengths" and "Opportunities" and against the topics gathered in the categories "Weaknesses" and especially "Threats".

Figure 3. SWOT – analysis from teachers' point of view; pros and cons



Source: The authors' elaboration.

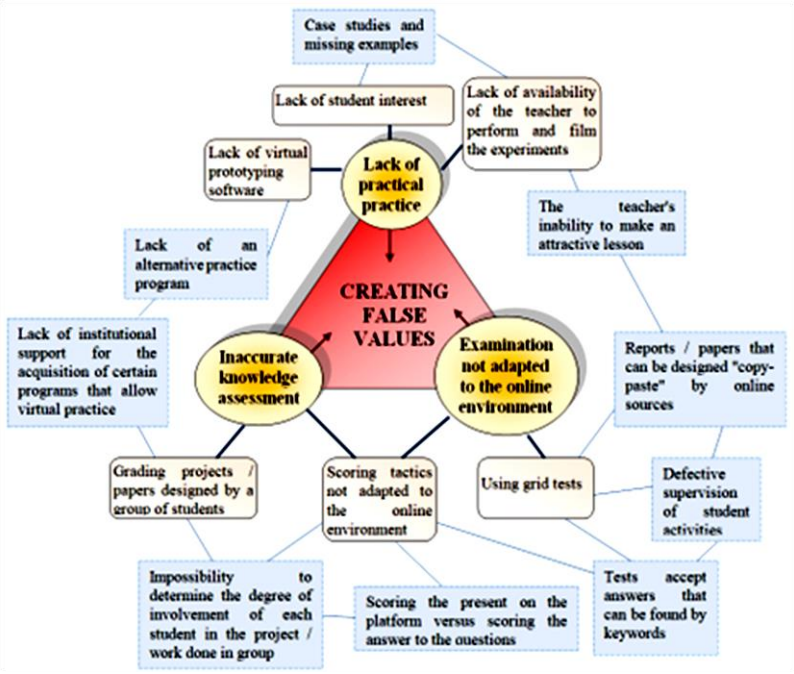
We believe that the pro-online education arguments in the *Strengths* and *Opportunities* represent a clear and opportune way for the future of education in the world. These arguments show that online education is cost-effective, reduce costs for all involved, and save valuable time. Thus, the arguments of *Weaknesses* and,

above all, of *Threats*, require the urgent solutions in order not to affect the quality of higher education and not only. Some themes of these last two categories, such as *Lack of institutional support*; *Lack of necessary equipment for online activity*; *Lack of skill in using online platforms* and *Lack of practical applications*, have obvious solutions and can be solved immediately by educational institutions, with further allocation of attention and budget. Instead, the arguments as the *Possibility of test fraud*; *Corrupted evaluation due to unlimited online copy sources* and *Creation of false values*, require the development of new methods, not found in traditional education. Comparing the responses of two participating parties, we see that students are pro-exams online, unlike the teaching staff, who believe that online exam results may be false due to the widespread possibility of copying from the online environment, and because the students cannot be seen in what they consult during the exam. These false results can eventually lead to the launch of false values in society. Moreover, some graduates may access positions in society for which they are not well prepared and which will seriously affect society as a whole or, through the decisions they will take, in ignorance.

5.4 Some Proposal for Improving the Sensitive Aspects of Online Education using Specific Tools of Quality Engineering

To find solutions to the main "Weaknesses" and "Threats", we have constructed an Interrelation Diagram (Figure 4), in which the causes leading to the main threat "Creation of false values" are related on three levels.

Figure 4. Interrelationship Diagram for the basic problem of online exams



Source: The authors' elaboration.

The main causes leading to the delicate issue of the creation of false values in society (red triangle), resulting from a corrupt online exam due to unlimited copying possibilities, are written in a circle. The pink rectangle represents the second-degree cases, relative to the main cases, and in the blue rectangle the third-degree cases. By analyzing the cascade of causes that determine the main problem of the online exam and analyzing their interrelation, we can easily find solutions to the main problem. To the problem caused by "Lack of practical practice", it is easy to see that the solution would be for teachers to have the ability to film the laboratories/workshops and make the lessons attractive to students. But this can only be seen as possible with the full support of the educational institution, allocating special funds and specialized personnel for this newly created field. Regarding the issue "Examination not adapted to the online environment" and "Inaccurate knowledge assessment", it is clear from the diagram that the solutions should go towards more complex exams, avoiding grid tests and avoiding group projects, with more than 2 students.

Following this approach, the authors designed an analysis based on the Quality Function Deployment methodology. QFD – is the methodology that allows the translation of the beneficiary's wishes in technical and quality characteristics of the product, using the quality tool - matrix diagram, which in the literature is also called "House of Quality". We have adapted this specific quality engineering tool to the issue of exclusively online education, in order to find the best solutions to solve the most pressing problems highlighted above (Figure 5), and we have issued seven possible solutions to the most sensitive issues raised by online teaching.

Figure 5. The QFD tool applied to find the best solutions

Symbol	Meaning
★★	Strong relation
★	Moderate relation
–	not obvious correlation
★★	Negative correlation
++	Strong affinity
+	Moderate affinity

	SOLUTIONS / MAIN PROBLEMS	1 Testing with "essay" type subjects; avoid grid tests	2 Testing "flash" after each chapter taught	3 Courses based on several case studies solved	4 Various and attractive test subjects and applicable in the chosen field	5 Equipping students with video-audio equipment for monitoring the activity	6 Involvement of technical staff in securing the online platforms	7 Training courses on the use of online platforms
1	Corrupt evaluation due to unlimited online copy sources	★★	★	★	★	★★	★	
2	Possibility of test fraud	★★	★★	★	★★	★★	★★	★
3	Loss of motivation	★	★★	★★	★★	★		★
4	Lack of practical applications	★	★	★★	★★			★
5	Lack of skill in using online platforms					★	★	★★
6	Lack of institutional support		★	★	★	★★	★★	★★
7	Corruption of online platforms	★	★			★	★★	★★
CONCLUSIONS :		Beware of negative correlations. Economic solution must be found						

Source: The authors' elaboration.

A cause can have several results and one result, several causes. The correlations according to the legend, demonstrated the following: Solution no. 1 - Testing with "essay" type subjects; avoid grid tests"; solution no.2 "Testing" flash "after each chapter taught" and solution no.4 "Various and attractive test subjects and applicable in the chosen field", respond very well to most of the problems raised (those on the left of the matrix), which required a corrupt evaluation of the possibility of unlimited copying from the online environment, but they also respond very well to the issue of loss of motivation and lack of practice. Frequent testing through essay-type tests trains and motivates the student, developing interest to subjects, and making connections between these. Solution no.3 "Courses based on several case studies solved" responds both to the first four problems raised by teaching in the online environment but successfully answers the problem "Loss of motivation" and "Lack of practical applications". This requires additional staff involved in proofreading and grading, and thus is quite difficult to manage even economically by the educational institution. Solutions no.5, 6 and 7 strongly depend on the involvement of the educational institution, both budgetary and with the use of qualified staff. In the second QFD matrix, called in the literature "the roof of the House of Quality", built above the first matrix, the compatibilities established between the solutions found were highlighted.

It is observed that the solutions found are perfectly correlated with each other and mutually enhance each other, but with one exception, they are economically sensitive. Solutions no. 1 and no. 2 are very helpful in problem solving, but unfortunately it involves additional effort on the part of both teaching staff and educational institutions. Therefore, teachers need to spend a lot of time to correcting non-grid tests, and they should devote even more time to "flash" tests after each chapter taught.

6. Conclusions

In this paper, we have carried out a comprehensive analysis of the unprecedented situation created by the pandemic, forcing educational institutions to adopt teaching exclusively online. In the first part, the positive and above all negative aspects of online education were analyzed. We explored the topic in the academic field to find the best ways to improve teaching exclusively online and the student-teacher relationship; more precisely, in the two universities where the authors are teachers, a questionnaire was launched among students, specially designed for the case study. At the macro level of the two Universities, the sample was not sufficiently representative of the student population given that the University of Bucharest has more than 30,000 students while the Politehnica University of Bucharest more than 25,000 and therefore this can be seen as a limitation to the study, while at the faculties' level the sample was large enough. The analysis of the responses received to the questionnaire, performed with specific statistical tools, highlighted the strengths, but also the sensitive points of online education, from the student's point of view.

To find the optimal solutions for a correct and attractive online teaching, we performed a new analysis using specific tools of quality engineering, also taking into account the opinions expressed by teachers. Therefore, we perform SWOT analysis that helps to create Interrelationship Diagram to better highlight the main problems related to online examination activities and consequent creation of false values. This diagram has been built on three levels, so that the remedies to solve these problems can be highlighted, and we designed seven solutions to these problems based on responses received from the students and teaching staff. To assess the extent to which these solutions respond to the identified problems, we used the QFD methodology and built a "house of quality" made up of two matrices. The basic matrix helps to study the degree of relationship of the solutions found with the problems highlighted by the interviews or by the analysis of questionnaire. The secondary matrix, "the roof of the quality house", highlights the affinity, which is created or not, between the solutions found and above all triggers an alarm signal if there is a negative correlation. This negative correlation requires finding another solution that satisfies the proposed purpose, without negative implications on the other solutions found. Our analysis and especially the solutions found can be useful for the possible step of higher education towards metaverse education.

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