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STATISTICAL CONFLUENCES AND QUALITATIVE APPROACHES TO THE PRESENCE OF MATHEMATICS IN ASEM CURRICULA

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Abstract: Currently the regulation on the organization of admission to higher education for the 2023/2024 academic year (and previous years) does not indicate the profile that candidates who opt for a certain field of professional training must have. It is worth mentioning that both candidates with bachelor's degree in the real profile, as well as those with humanist profile, arts or sports have same access to the general field of study Economic Sciences. Thus, obviously, the background is different for all candidates.

In this paper, we aim to explore the knowledge in mathematics that candidates in the general field of study of economics possess, as in the first semester at all specialties in the field of Economic Sciences, students have the course unit Mathematics for Economists or Linear Algebra and Mathematical Analysis.

Now students are not selected at the beginning of the semester in terms of their knowledge of mathematics, respectively, those with a real profile have an advantage over those with a humanist profile. This paper aims to investigate this problem.

Keywords: mathematics for economists, mathematics for business, questioner, survey.

JEL Classification: A2, C8

Introduction

When the university lecturer prepares the curriculum for a course unit he relies on the fact that the student knows certain compulsory topics that he should know from high school/college. In this article we will address the following topic: Does the applicant for economic studies have sufficient mathematical knowledge to pass the Economic Mathematics (hereafter EM) or Linear Algebra and Mathematical Analysis (hereafter LAMA) exam, course units found in the curriculum for the bachelor programs within the Academy of Economic Studies from Moldova. Question arises because the curriculum for these subjects are drawn up with the idea that the student is a former high school student with a real study profile, either with a humanist profile, but who has the necessary mathematical knowledge.

The idea of researching the subject came after the change of the national curriculum for the discipline of Mathematics (National Curriculum, 2020). Specifically, the exclusion of certain subjects absolutely necessary for the course units stated above.

The premises and purpose of the research

The problem of lack of adequate knowledge in the field of mathematics is an important one that we have been studying for several years. Our first study that detected the existence of this problem was influenced by the forced transition to online education due to the COVID-19 pandemic and how it influenced the economic mathematics course unit (Chicu O., Chicu V., 2021, p.57), followed by the study that aimed to analyse the students' opinion towards distance education, including how this form of education would influence the Economic Mathematics course (Chicu O., Chicu V., 2022, p. 237). The impetus for the current study was the modification of the national curriculum for high school (grades X-XII). But also the fact that the mathematics curriculum in high school does not "explain" to the student that if he follows the humanist profile, he will not have sufficient knowledge to follow a real profile study program at the university. The fact that fundamental topics such as the derivative or the integral have been excluded in the national curriculum for the discipline of mathematics and the fact that after finishing high school they are allowed without restrictions to follow any bachelor program, in our opinion, misleads pupils/students and they are confused when, after the humanist profile, they enter the auditorium at the EM or LAMA course units. For the purpose of a detailed research of the presence of mathematics in the ASEM curriculum, high school mathematics curriculum and the curriculum for the EM and LAMA course units, from the 1st semester, for the bachelor programs within the faculties Business and business administration, Finance, Accounting, International economic Relations, General Economics and Law and Information Technologies and Economic Statistics respectively were examined. Also, a survey was conducted in which participated students of the 1st year of studies, academic year 2022-2023.

Analysis of Mathematics curriculum for high school (grades XI-XII)

The young man, who chose to train as a specialist in an economic field, comes from a school environment, where he accumulated primary knowledge to be able to understand the content of the university subject, which uses a complex mathematical apparatus in order to exhaustively model economic phenomena.

Curricula in both EM and LAMA course units are aimed at training the skills to rationalize, analyze, logically investigate economic phenomena through the prism of mathematical modelling, to use deduction and induction in the analytical and research component of economic processes.

ME course unit curriculum includes the topics: functions of several variables, differential equation (1st and 2nd order), systems of linear equations, linear programming, elements of probability, and in

the LAMA curriculum we can find the additional topics: series, vector spaces and operators. Studying these topics is based on good mathematical knowledge.

Analyzing the national curriculum for high school (grades XI-XII), we attest that students who follow the real profile study in depth both quantitatively and qualitatively such topics as limits and derivatives of the function of a variable (grade XI) and integrals (grade XII). But these topics are not found in the curriculum for students following the humanist profile, topics that are so necessary for studying programs with an economic profile, informatics or engineering within university studies. Thus, is created a major discrepancy in content approaches, required mathematical knowledge being practically impossible to recover qualitatively in order to create a good mathematical basis for the understanding and effective use of mathematical tools in the modelling of economic processes.

On the one hand, the curriculum for the humanist profile does not include the subjects absolutely necessary for the formation of the minimum necessary and sufficient mathematical knowledge to be able to apply to an economic, computer science or engineering profile study program; on the other hand, the Ministry of Education, Culture and Research (MECR) university admissions regulation allows any candidate to apply for the respective programs, regardless of his study profile, which creates, at least, confusion.

Results of the questionnaire

Around 49% of the students who took the LAMA course unit and 38% of the students who took the EM course unit participated in the questionnaires. Students from the Faculty of General Economics and Law have the highest participation rate in the questionnaire (95%), the lowest participation rate was certified by students from the Faculty of Business and business administration (22.4%), for students from the other faculties' participation rate was on average 50%. It should be noted that the survey was mainly attended by students who attended lectures and seminars. Thus, 71% of the respondents indicated that they attended 50%-75% and 75%-100% of the classes (figure 1).

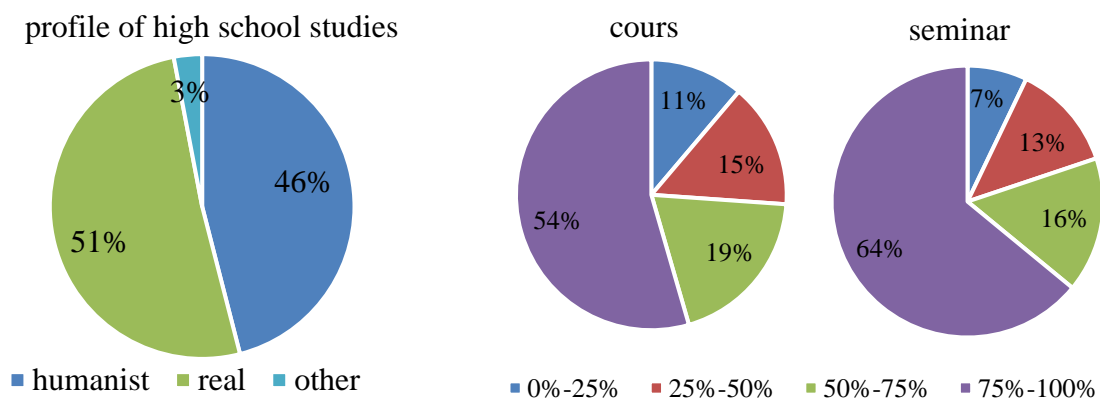


Figure 1. Attendance at lectures and seminars and the study profile of the respondents

Source: Elaborated by the authors based on survey results

According to the results of the survey, 64.9% of those surveyed passed the BAC exam in mathematics, however 46.8% of the respondents indicated the real profile. Thus, it appears that 18.1 pp of the students chose the mathematics exam as their choice exam at the BAC. According to admission data, among the candidates admitted to study in first year, 57% took the BAC in mathematics.

34.2% of the students indicated that the knowledge acquired during their high school/college studies is sufficient to master the EM and LAMA courses units, 47.7% indicated that the knowledge is not sufficient. However, analysing the answers by study profiles, we note that 66.4% of the students with a humanist profile indicated that they have insufficient knowledge in mathematics to acquire the two subjects in the 1st year, versus 62.7% of the students with a real profile who indicated that they possess sufficient knowledge (figure 2).

The answer to the question of whether the students understand everything that is explained at the course/seminar in the two unit courses in the first semester is also of interest. Thus, 37.8% of the respondents indicated that they understand everything, 24.3%, despite having a good mathematical knowledge, still do not understand the subjects, and 37.8% do not understand due to the lack of basic knowledge in the field. The same thing analysed according to the criterion of taking the Bacalaureat exam in mathematics shows that 51% of the students who took the BAC in mathematics understand everything that is explained in the respective unit course at the university versus 27% of those who did not take this exam. According to the study, 49% of the students who took the Mathematics at BAC exams and 73% of those who did not take it do not understand what is explained at the course/seminar.

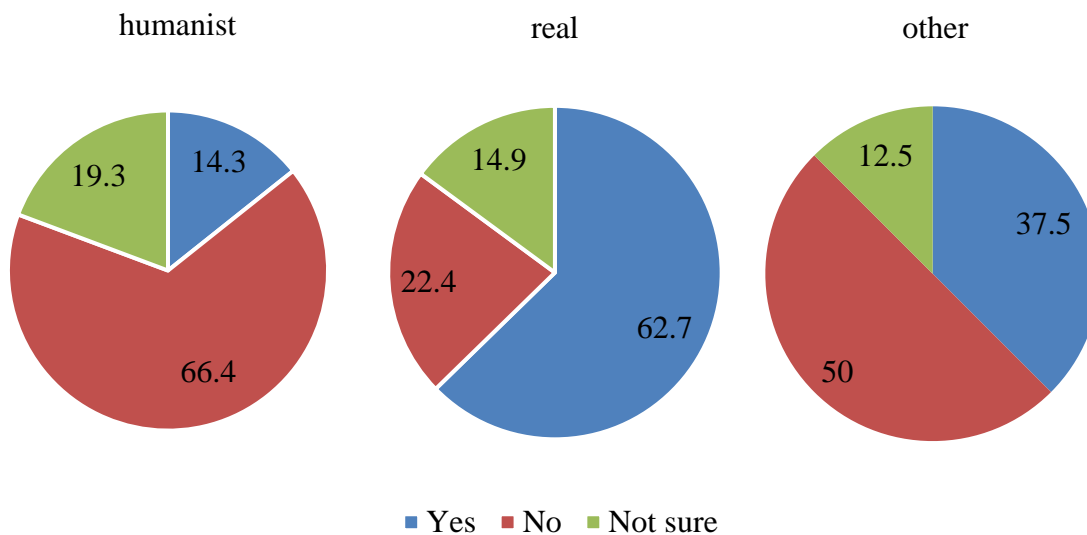


Figure 2. The knowledge acquired in high school/college is sufficient to master the subject (%)

Source: Elaborated by the authors based on survey results

If we analyse the students' answers to the question of whether they understand everything that is explained at the course together with their answers to the question of whether the knowledge acquired in the field of mathematics during their studies in high school/college is sufficient to master the two unit courses in the 1st semester at the university, then 45% of the respondents who indicated that the knowledge from high school is sufficient understand everything explained at the course/seminar because they have a good mathematical knowledge. Also of interest are the 34% of respondents who indicated that they understand also because the teachers explain the subject very well. However, 14% indicated that although they have a good training in mathematics, they still do not understand the subject (table 1). This percentage can be explained by various reasons, one of them could be that first year students have not yet been able to understand what the university learning process is and that it differs from high school/college, and that there are many hours dedicated to studying individually, hours that first-year students often ignore and do not use for self-study.

The curriculum for EM and LAMA subjects are built around certain mandatory knowledge that students should have when they enter the classroom. Analysing some of the topics that students should know, we notice, for example, that only 58.5% know how to solve examples in the topic *Operations with real numbers* and only 24.5% know how to solve examples in *Probabilities*. All the results can be consulted in table 2.

Table 1. The reasons for understanding/not understanding the subject at the course/seminar

You understand everything explained in the EM and LAMA course/seminar:	The knowledge acquired in high school/college is sufficient to master the subject at EM and LAMA:		
	Yes	No	Not sure
<i>Yes - because I have a good background in mathematics</i>	45%	0,86%	7,14%
<i>Yes - because the teacher explains very well</i>	34%	9,84%	28,57%
<i>No - I have a good background, but I still don't understand</i>	14%	31,03%	21,43%
<i>No - because I don't have a good background in mathematics</i>	7%	58,62%	42,86%

Source: Elaborated by the authors based on survey results

Table 2. Basic knowledge (%)

Topic	Students know how to solve examples							
	Yes		Just some examples		No		Not sure	
	H*	R*	H*	R*	H*	R*	H*	R*
Operations with real numbers	58,5		27,2		4,9		7,9	
	45,5	71,6	32,8	20,9	8,4	2,2	11,8	5,2
Systems of equations	54,3		27,5		5,3		8,7	
	39,5	67,2	36,1	20,9	10,1	1,5	12,6	5,2
Limits	26		29,8		15,8		22,3	
	8,4	41,8	23,5	36,6	29,4	5,2	34,5	10,4
Determinants of 2nd and 3rd order	27,9		36,2		12,8		17,4	
	12,6	41	27,8	35,8	20,2	7,5	26,9	9
Derivatives	36,6		28,7		11,7		18,9	
	17,6	52,2	29,4	28,4	23,5	2,2	27,7	11,9
Integrals	26,4		30,6		17,7		20,4	
	8,4	42,5	26,1	35,1	33,6	4,5	30,3	11,2
Probability	24,5		30,9		15,1		24,5	
	15,1	31,3	29,4	33,6	26,9	6	26,9	22,4

H* – humanist profile

R* – real profile

Source: Elaborated by the authors based on survey results

According to the survey results, 27.9% of respondents indicated that they took private lessons (paid by the student) during 1st semester to prepare for seminars and assessments in the EM and LAMA course units.

Indeed, it is necessary to specify that in the educational plans there is the course *Elements of mathematics in economics* which would be very useful for students from the humanist profile or for those with a weaker mathematical knowledge.

But the results of the survey show that 45.9% of the respondents are not informed about the existence of this course in curriculum and, if they had known from the beginning of the year about the existence of this course unit, 35.1% of all respondents would have opted for it. 19.8% would not have opted for it, the others being undecided.

It is worth noting that analysing the results of the final evaluation for students that took part in this study, the passing rate for the Linear Algebra and Mathematical Analysis course unit is 98% (the exam taken on the first attempt). For the Economic Mathematics course unit, the pass rate was 84%. In the existing conditions, when for example only 58.5% of the respondents indicate that they know the topic *Operations with real numbers* (Table 1), its foundations being laid in grades 5-7, this is a very high pass rate. It can be explained by the fact that teachers are quite lenient and often make the examples proposed for tests and exams easier. This aspect deserves to be studied separately.

Conclusions and recommendations

According to the results of the study, 49% of the respondents indicated that they have a different profile than the real one, but analysing the situation as a whole, only 37% of the 1st year students, exclusive of the students who do their studies in part-time learning, have the real study profile and 63% are from humanist or another, for the other 14% the study profile is not known. The research of the respective curriculum clearly showed that in the high school program for the profiles other than the real one, the minimum topics required to pass the EM and LAMA course units is not included. Thus, in the existing conditions, a quick method to improve the situation is to promote the optional course *Elements of economic mathematics* among the students of the 1st year, right from the moment of applying to the university. Of course, the ideal method would be to organize a test for the minimum necessary mathematical knowledge that an applicant for studies in the field of economics or computer science and engineering must possess (we are referring here to the students of the Faculty of Information Technologies and Economic Statistics). This minimum knowledge is necessary not only for the two course units studied in this article, but also for other course units found in curriculum.

The lack of elementary mathematical knowledge for students who come to real profile study programs is a problem not only within ASEM, but also in general in the Republic of Moldova. Thus, we insist, that the solution would be to organise entrance exams for mathematics. Although universities have autonomy in terms of setting entrance exams, a single institution cannot afford (from a financial point of view) to organize this exam alone. It would be very good if the admission regulations drawn up by the Ministry of Education, Culture and Research would include the obligation of such an admission exam.

We also consider it absolutely important either to introduce the fundamental topics back into the high school curriculum or to limit the access to real profile study programs at the university of candidates who have finished the humanist profile.

This change should be highly publicized, not sudden, and refer to candidates who will apply for university in 3 years, so that 9th graders are informed about the admission conditions to the university that will concern them in 3 years' time.

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