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A Science-Oriented High School Mathematics Curriculum Framework for Supporting STEM Preparedness in Higher Education

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This study develops an evidence-informed curriculum framework for the science-oriented track of Albanian high schools and examines how current and former STEM (science, technology, engineering, and mathematics) students perceive the alignment between secondary mathematics preparation and first-cycle university requirements. The study used an exploratory descriptive design that combined a researcher-developed questionnaire with curriculum mapping. The questionnaire was completed by 500 current or former STEM students from Albanian and international universities. Responses were analysed with descriptive statistics, including percentages of negative, neutral, and positive responses and modal preferences for the instructional period in which each subject should be taught. The results show that respondents did not reject the existing curriculum wholesale; rather, they expressed mainly neutral perceptions, with stronger concerns about instructional hours, topic sequencing, and concept sufficiency in analytic geometry, calculus, discrete mathematics, and probability and statistics. Based on these findings and prerequisite relationships among mathematics topics, the study proposes a three-year, nine-period sequence: Arithmetic, Algebra, Plane Geometry, Trigonometry, Analytic Geometry, Solid Geometry, Calculus, Discrete Mathematics, and Probability and Statistics. The contribution of the study is not an empirical demonstration that the curriculum improves STEM achievement, but a structured and transparent curriculum framework that can guide curriculum review, textbook sequencing, teacher planning, and future validation studies. The proposed framework should therefore be interpreted as a design recommendation requiring expert review, classroom piloting, and longitudinal evaluation before system-wide implementation.

Keywords: high school mathematics, science-oriented curriculum, STEM preparedness, curriculum alignment, secondary-tertiary transition, Albania

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INTRODUCTION

A strong foundation in mathematics is a major requirement for students who enter science, technology, engineering, and mathematics (STEM) programs in higher education. In undergraduate STEM programs, mathematics is not only a separate course sequence but also a language for modelling, proof, data analysis, engineering design, computation, and scientific explanation (English, 2016; Li et al., 2020). For this reason, secondary mathematics curricula should prepare students for both procedural fluency and conceptual reasoning, because students who enter university without these foundations may experience difficulty in calculus, linear and analytic reasoning, probability, statistics, and mathematically intensive disciplinary courses.

The transition from secondary school to university mathematics is widely recognized as demanding. Students are often required to move from computational and example-based forms of school mathematics toward more abstract, formal, and proof-oriented forms of reasoning in higher education (Tall, 2008; Di Martino et al., 2023). This transition can affect not only students' achievement in mathematics courses but also their engagement with physics, engineering, computer science, data science, and other STEM subjects that depend on mathematical modelling and symbolic reasoning.

Preparedness for higher education therefore refers to more than the number of topics covered in high school. It includes the depth with which topics are understood, the order in which ideas develop, the amount of instructional time available for practice and consolidation, and the extent to which students can transfer mathematical concepts to new STEM contexts. Curriculum alignment and learning progression are particularly important because disconnected coverage of topics may leave students with isolated procedures rather than integrated mathematical understanding (Clements & Sarama, 2004; National Council of Teachers of Mathematics [NCTM], 2014).

In the Albanian context, many students who complete the science-oriented high school track continue into STEM programs in Albania or abroad. At the same time, university STEM curricula have increasingly been modernized and aligned with contemporary international standards. These developments create a need to examine whether the secondary mathematics curriculum provides a sufficiently coherent pathway to university-level STEM study. This need is especially important in mathematics-intensive programs such as mathematics, informatics, physics, engineering, computer science, data science, and business informatics.

The research gap addressed in this article is twofold. First, existing discussions of STEM preparation often emphasize general STEM integration, but they provide less context-specific evidence about the sequencing of high school mathematics subjects for students who intend to pursue STEM studies. Second, the Albanian science-oriented mathematics curriculum has not been sufficiently examined from the perspective of students who have already encountered university-level STEM mathematics demands. This study responds to that gap by using students' perceptions as one source of evidence, while also interpreting the results through curriculum alignment and prerequisite relationships among mathematics topics.

The objective of the study is to propose a science-oriented high school mathematics curriculum framework that is better aligned with the mathematical demands of higher education STEM programs. The study does not claim to test the effectiveness of the proposed curriculum experimentally. Instead, it uses descriptive survey evidence and curriculum mapping to justify a coherent structure that can be reviewed, piloted, and validated in future work.

The study was guided by the following research questions: (1) How do current and former STEM students evaluate the level, instructional hours, sequencing, instructional period, and concept sufficiency of key secondary-school mathematics subjects? (2) Which sequence of mathematics subjects is most strongly supported by respondents' period preferences and by prerequisite relationships among topics? (3) What practical implications and limitations should be considered when using the findings to inform curriculum reform for STEM preparedness in higher education?

LITERATURE REVIEW AND CONCEPTUAL FRAMEWORK

Secondary-tertiary transition in mathematics. Research on the transition from school to university mathematics emphasizes that students often face a cognitive and epistemological shift. At school, mathematical activity may focus primarily on procedures, worked examples, and familiar problem types. At university, students are expected to work with definitions, proof, abstraction, modelling, and applications across disciplinary contexts (Tall, 2008; Di Martino et al., 2023). These differences help explain why students can be successful in secondary mathematics yet still struggle in first-year STEM mathematics courses.

Mathematics preparedness in STEM pathways. Longitudinal research indicates that advanced secondary mathematics participation is associated with later entry into STEM study and professions (Nitzan-Tamar & Kohen, 2022). Similarly, studies of college calculus highlight the importance of students' prior mathematical preparation and the role of calculus as a gateway to further STEM study (Bressoud et al., 2015). In this sense, mathematics preparedness is not restricted to mathematics majors; it supports learning across physics, engineering, computer science, statistics, data science, and technology-related fields.

Curriculum coherence and learning trajectories. A curriculum designed for STEM preparedness should be vertically coherent. Learning trajectories describe how students' mathematical thinking develops across levels and how instruction can support movement toward more advanced concepts (Clements & Sarama, 2004). Curriculum coherence also requires a logical ordering of prerequisite ideas. For example, algebra and functions support trigonometry, analytic geometry, calculus, discrete mathematics, and probability; geometry and trigonometry support analytic and spatial reasoning; and probability and statistics support data-based reasoning in science and technology. These connections justify a curriculum that sequences subjects according to conceptual dependencies rather than treating each subject as an isolated block.

Integrated STEM and mathematical reasoning. Integrated STEM education emphasizes the use of knowledge across disciplinary boundaries and often involves problem-

cantered, inquiry-based, design-based, and collaborative learning (English, 2016; Thibaut et al., 2018; Yildirim & Selvi, 2017). For mathematics curricula, this means that topics should not be included only because they are traditional. They should also support reasoning, modelling, problem solving, and transfer to scientific and technological contexts. Accordingly, a science-oriented mathematics curriculum should balance content coverage with depth, application, and progression.

Conceptual framework. The analysis in this study is organized around three complementary dimensions. The first is curriculum alignment: the extent to which secondary mathematics topics correspond to first-cycle STEM requirements. The second is vertical progression: the order in which topics are placed so that later subjects build on earlier ones. The third is perceived readiness: students' evaluations of topic level, instructional hours, sequencing, period placement, and concept sufficiency. These dimensions provide the logic for moving from descriptive survey results to a cautious curriculum proposal.

METHOD

Research design

The study used an exploratory descriptive design combining a perception survey with curriculum mapping. The survey component identified how current and former STEM students evaluated the science-oriented mathematics curriculum. The curriculum-mapping component used the survey results together with prerequisite relationships among mathematics subjects to formulate a proposed three-year sequence. Because the study did not include an intervention, pretest-posttest design, control group, or achievement measure, the proposed framework should not be interpreted as a statistically validated effectiveness model.

Educational context

Albanian upper-secondary education in the science-oriented track is organized across three years, with three instructional periods in each year. This structure creates nine curriculum slots. The study therefore examined nine mathematics subjects that could form a progressive pathway to university STEM study: Arithmetic, Algebra, Plane Geometry, Trigonometry, Analytic Geometry, Solid Geometry, Calculus, Discrete Mathematics, and Probability and Statistics.

Participants and sampling

The questionnaire was completed by 500 current or former students of STEM programs. Approximately 76% of respondents were affiliated with 14 Albanian universities, while approximately 24% were affiliated with 13 universities abroad. The inclusion criteria were enrolment in, or completion of, a STEM-related program such as mathematics, informatics, physics, mathematics-informatics, mathematics-physics, engineering, data science, computer science, information technology, or business informatics. Students in first-cycle programs were expected to be in their second or third year so that they had already encountered foundational university mathematics. The available manuscript information does not report a random selection procedure; therefore, the sample is best described as a non-probability purposive and convenience sample of STEM students with relevant transition experience.

Research instrument

The questionnaire was developed by the author(s) for this study. It included a section on respondent background, a general section with five items about the mathematics curriculum as a whole, and nine subject-specific sections. For each of the nine subjects, respondents answered five common questions about the appropriateness of the knowledge level, sufficiency of instructional hours, logical sequencing of topics, preferred instructional period, and sufficiency of concepts and knowledge. Responses to evaluative items used a five-point Likert scale: 1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree, and 5 = strongly agree. Respondents were also able to provide written suggestions. To support informed responses, participants received a brief document describing the chapters included in each of the nine subjects.

Questionnaire quality and boundaries

The questionnaire has content relevance because its items are directly aligned with the study's five curriculum-evaluation dimensions and were repeated consistently across all nine subjects. The supporting chapter descriptions also helped respondents evaluate comparable content. However, the original manuscript did not report formal expert validation, pilot testing, factor analysis, or reliability coefficients. For that reason, the instrument should be treated as a structured curriculum-perception tool rather than a psychometrically validated scale. This limitation is acknowledged in the Discussion and should be addressed in future validation studies.

Data collection

Data collection lasted approximately six months, from October 2025 to March 2026. This period allowed the authors to reach students studying both in Albania and abroad, including students who returned home at different times. The average completion time was approximately 25 minutes.

Data analysis

The quantitative data were analysed using descriptive statistics. For the five-point items, frequencies were converted into percentages. To improve clarity, the revised analysis reports three response categories: negative responses (strongly disagree + disagree), neutral responses, and positive responses (agree + strongly agree). For the item on instructional period, the modal response was used to identify the period most frequently selected for each subject. No inferential tests were conducted because the study used a non-probability sample and the objective was curriculum exploration rather than population inference. The proposed curriculum sequence was determined by combining (a) modal period preferences, (b) descriptive patterns of perceived sufficiency and sequencing, and (c) prerequisite relationships among mathematics subjects.

Ethical Considerations

The manuscript now includes the necessary ethical information. Written informed consent was obtained from all participants prior to data collection. All participant data were anonymized and handled confidentially in accordance with applicable data protection guidelines.

FINDINGS

Overall curriculum evaluation. Table 1 summarizes the institutional distribution of the respondents, and Table 2 reports the general evaluation of the science-oriented mathematics curriculum. Across the five general items, neutral responses were substantial, ranging from 37.6% to 54.6%. This pattern suggests that respondents did not provide a strong overall endorsement of the existing curriculum, but they also did not reject it entirely. The most critical general item concerned the sufficiency of mathematical concepts and knowledge, where negative responses (36.2%) exceeded positive responses (26.2%).

Table 1
Respondents by university affiliation

Albanian university	n	International university	n
Fan S. Noli University	92	University of Cambridge	4
Aleksandër Xhuvani	19	Polytechnic of Milano	5
Ismail Qemali University	13	Polytechnic of Torino	4
Luigj Gurakuqi University	23	RWTH Aachen University	7
Aleksandër Moisiu University	19	University of Oxford	3
European University of Tirana	16	ETH Zurich	2
Polytechnic University of Tirana	77	Aristotle University	28
Eqrem Çabej University	3	Sorbonne University	6
New York University of Tirana	14	Eindhoven University of Technology	4
Polis University	4	Technical University of Munich	5
Epoka University	9	Sapienza University of Rome	16
Albanian University	9	Kapodistrian University of Athens	27
University of Tirana	82	Delft University of Technology	2
Logos University College	7		
		Total	500

Note. Institutional names have been standardized for readability where necessary.

Table 2
General evaluation of the science-oriented mathematics curriculum (%)

Item	Focus	1	2	3	4	5	Negative	Neutral	Positive
Q 1	Overall topic level	6.6	20.4	54.6	15.8	2.6	27.0	54.6	18.4
Q 2	Instructional hours	4.2	18.2	40.2	31.2	6.2	22.4	40.2	37.4
Q 3	Topic sequencing	3.2	16.2	48.2	26.6	5.8	19.4	48.2	32.4
Q 4	Cross-grade progression	13.8	14.8	38.8	28.8	3.8	28.6	38.8	32.6
Q 5	Concept sufficiency	10.4	25.8	37.6	18.8	7.4	36.2	37.6	26.2

Note. 1 = strongly disagree; 2 = disagree; 3 = neutral; 4 = agree; 5 = strongly agree. Negative = 1 + 2; positive = 4 + 5. Full item wording is summarized in the Method section.

The general results indicate a curriculum that is perceived as moderately aligned but insufficiently strong in depth and coherence. In particular, the dominance of neutral responses should not be interpreted as evidence of adequacy. In curriculum evaluation, a high neutral proportion may indicate uncertainty, uneven student experiences, or insufficiently visible alignment between high school topics and university STEM expectations.

Subject-level evaluations. Tables 3 and 4 aggregate the subject-level results. The aggregation reduces repetition and makes the main patterns more visible. For knowledge level, Analytic Geometry received the highest positive evaluation (42.3%), followed by Plane Geometry (38.5%) and Trigonometry (36.9%). However, several subjects had high neutral responses, especially Discrete Mathematics (54.4%), Solid Geometry (50.6%), and Calculus (49.2%).

Table 3
Aggregated subject-level evaluations for knowledge level and instructional hours (%)

Subject	Knowledge negative	Knowledge neutral	Knowledge positive	Hours negative	Hours neutral	Hours positive
Arithmetic	26.0	46.6	27.4	27.0	54.6	18.4
Algebra	30.4	47.2	22.4	17.6	38.4	44.0
Plane Geometry	21.3	40.2	38.5	28.4	58.2	13.4
Trigonometry	25.3	37.8	36.9	22.0	50.2	27.8
Analytic Geometry	24.3	33.4	42.3	40.6	48.2	11.2
Solid Geometry	29.5	50.6	19.9	38.0	40.6	21.4
Calculus	17.5	49.2	33.3	41.4	41.6	17.0
Discrete Mathematics	32.3	54.4	13.3	50.0	38.4	11.6
Probability and Statistics	35.9	40.9	23.2	57.0	31.4	11.6

Note. Negative = strongly disagree + disagree; positive = agree + strongly agree.

Table 4
Aggregated subject-level evaluations for sequencing and concept sufficiency (%)

Subject	Sequencing negative	Sequencing neutral	Sequencing positive	Concepts negative	Concepts neutral	Concepts positive
Arithmetic	26.6	40.8	32.6	32.8	50.8	16.4
Algebra	26.6	36.2	37.2	25.2	39.4	35.4
Plane Geometry	44.6	30.2	25.2	35.0	30.4	34.6
Trigonometry	39.4	50.2	10.4	32.8	60.2	7.0
Analytic Geometry	38.8	54.2	7.0	52.4	41.8	5.8
Solid Geometry	33.6	39.4	27.0	28.6	30.2	41.2
Calculus	43.0	38.6	18.4	42.0	42.2	15.8
Discrete Mathematics	51.8	33.6	14.6	51.4	42.4	6.2
Probability and Statistics	58.6	32.3	9.1	55.0	34.2	10.8

Note. Aggregated values are computed from the five-point response distributions in Appendix B.

The results for instructional hours are more critical. Negative responses were especially high for Probability and Statistics (57.0%), Discrete Mathematics (50.0%), Calculus (41.4%), Analytic Geometry (40.6%), and Solid Geometry (38.0%). This pattern

suggests that students perceive later or more advanced topics as needing greater time allocation or stronger development. Similar concerns appear in the sequencing results: Probability and Statistics (58.6%), Discrete Mathematics (51.8%), Plane Geometry (44.6%), and Calculus (43.0%) had high negative evaluations. Finally, concept sufficiency was rated most critically for Probability and Statistics (55.0%), Analytic Geometry (52.4%), Discrete Mathematics (51.4%), and Calculus (42.0%).

Preferred instructional sequence. Table 5 presents the modal period preferred by respondents for each subject. The strongest agreement concerned the placement of Calculus in Grade 12, first period (93.2%), Probability and Statistics in Grade 12, third period (95.8%), Discrete Mathematics in Grade 12, second period (85.2%), and Arithmetic in Grade 10, first period (82.2%). These results support a progressive sequence from foundational number and algebraic reasoning toward analytic, spatial, calculus-based, discrete, and statistical reasoning.

Table 5
Aggregated subject-level evaluations for sequencing and concept sufficiency (%)

Grade	Instructional period	Subject	Respondents selecting this placement
Grade 10	1st instructional period	Arithmetic	82.2%
Grade 10	2nd instructional period	Algebra	74.8%
Grade 10	3rd instructional period	Plane Geometry	57.8%
Grade 11	1st instructional period	Trigonometry	59.6%
Grade 11	2nd instructional period	Analytic Geometry	70.4%
Grade 11	3rd instructional period	Solid Geometry	60.4%
Grade 12	1st instructional period	Calculus	93.2%
Grade 12	2nd instructional period	Discrete Mathematics	85.2%
Grade 12	3rd instructional period	Probability and Statistics	95.8%

Note. The percentage is the highest period-selection percentage for each subject.

Proposed curriculum framework. Table 6 shows the revised curriculum framework that emerges from the combined analysis. The framework is intentionally cautious. It is not presented as proof that the proposed curriculum will improve student achievement; rather, it is a structured sequence that aligns student perceptions with mathematical prerequisite relationships and the demands of higher education STEM study.

Table 6
Proposed three-year science-oriented mathematics curriculum framework

Grade	Period	Subject	Role in STEM preparedness
Grade 10	1st instructional period	Arithmetic	Foundation for number sense, functions, and later algebraic reasoning.
Grade 10	2nd instructional period	Algebra	Core symbolic language for functions, equations, sequences, matrices, and modelling.
Grade 10	3rd instructional period	Plane Geometry	Development of planar reasoning, proof foundations, transformations, and measurement.
Grade 11	1st instructional period	Trigonometry	Bridge from functions to periodic models and applications in physics and engineering.
Grade 11	2nd instructional period	Analytic Geometry	Coordinate-based bridge between algebra, geometry, space, and calculus applications.
Grade 11	3rd instructional period	Solid Geometry	Spatial reasoning for three-dimensional geometry, measurement, and STEM visualization.
Grade 12	1st instructional period	Calculus	Gateway to rates of change, accumulation, optimization, and university STEM mathematics.
Grade 12	2nd instructional period	Discrete Mathematics	Reasoning for algorithms, combinatorics, recurrence, computing, and mathematical structures.
Grade 12	3rd instructional period	Probability and Statistics	Data, uncertainty, inference, and empirical reasoning for science and technology contexts.

Note. The framework combines modal preferences, prerequisite relationships, and curriculum-alignment considerations.

DISCUSSION

What the findings reveal beyond the survey percentages. The findings suggest that the central problem is not simply whether specific topics are present in the curriculum. Instead, the concern is whether topics are sufficiently developed, coherently sequenced, and allocated enough time to support transfer to university STEM learning. This interpretation is supported by the high neutral responses and by the stronger negative evaluations for instructional hours, sequencing, and concept sufficiency in advanced topics such as analytic geometry, calculus, discrete mathematics, and probability and statistics.

The neutral responses are important. They may indicate that students experienced the curriculum differently across schools, that they were unsure how to judge alignment after entering university, or that the curriculum includes topics but does not develop them deeply enough for later use. Therefore, the neutral pattern should be interpreted as a signal for curriculum review rather than as a satisfactory middle point.

Relationship to previous studies. The findings are consistent with research showing that the transition to university mathematics requires students to adapt to abstraction, proof, and more formal reasoning (Tall, 2008; Di Martino et al., 2023). They also align with research indicating that secondary mathematics pathways are connected to STEM participation and persistence (Nitzan-Tamar & Kohen, 2022). The particular concern about calculus is also consistent with studies describing calculus as a gateway course for STEM programs (Bressoud et al., 2015).

The study also extends the literature by providing a context-specific curriculum framework for the Albanian science-oriented track. Rather than proposing integrated STEM activities in general, it identifies a mathematics sequence designed to support STEM preparedness through vertical coherence. This is useful because mathematics often functions as the enabling discipline for later STEM learning, even when it is not the explicit focus of integrated STEM reform.

Practical implications. For curriculum designers, the proposed sequence provides a basis for reviewing whether each period has a clear role in preparing students for later mathematical demands. For textbook authors, the findings suggest that topic progression and concept sufficiency should be made more explicit, especially in the later subjects. For teachers, the framework highlights the need to connect topics across years, for example by linking algebraic functions to trigonometry, analytic geometry, calculus, and probability models. For higher-education institutions, the results support closer dialogue with secondary schools about the mathematical competencies expected in first-year STEM courses.

Alternative methodologies. Several additional methodologies could strengthen future research. Expert-panel review or a Delphi study could validate the proposed sequence with secondary teachers, university lecturers, curriculum specialists, and STEM program coordinators. Comparative document analysis could examine the alignment between Albanian textbooks and university syllabi in greater detail. Interviews and focus groups could explain why students selected neutral responses. Finally, a longitudinal or quasi-experimental study could evaluate whether students taught through the revised sequence perform better in university STEM mathematics courses.

Limitations. The study has several limitations. First, the sample was non-probabilistic and therefore cannot be assumed to represent all Albanian STEM students. Second, the questionnaire measured perceptions rather than achievement, and perception data cannot demonstrate curriculum effectiveness. Third, the original manuscript did not report formal questionnaire validation or reliability evidence. Fourth, the comparative curriculum mapping was conceptual rather than a documented systematic content analysis of specific secondary textbooks and university syllabi. Fifth, ethical approval and informed-consent procedures were not reported in the original manuscript and must be documented before publication. These limitations require caution in interpreting the proposed framework.

Future research. Future studies should validate the questionnaire, collect qualitative explanations for students' ratings, include teachers and university lecturers, and analyse actual curricular documents and textbook tasks. After expert review, the proposed framework should be piloted in selected schools and evaluated using student achievement, retention in STEM pathways, and performance in first-year university mathematics courses.

CONCLUSION AND SUGGESTIONS

This study proposed a science-oriented high school mathematics curriculum framework intended to support STEM preparedness in higher education. Based on descriptive responses from 500 current and former STEM students, the curriculum appears to be

perceived as moderately aligned with university needs but insufficiently strong in several areas. The most important concerns relate to the depth, instructional time, sequencing, and sufficiency of advanced or transition-critical topics, particularly analytic geometry, calculus, discrete mathematics, and probability and statistics.

The proposed three-year sequence is Arithmetic, Algebra, Plane Geometry, Trigonometry, Analytic Geometry, Solid Geometry, Calculus, Discrete Mathematics, and Probability and Statistics. This sequence is supported by respondents' modal preferences and by the logic of mathematical prerequisites. Its academic contribution is the development of a transparent framework that links student perceptions, curriculum alignment, and vertical progression. The framework can be used as a starting point for curriculum review, but it should not be interpreted as confirmed evidence of improved STEM achievement.

For policymakers, the study suggests that curriculum reform should focus not only on adding topics but also on improving coherence, instructional time, and conceptual depth. For educators, the findings encourage stronger cross-topic connections and more explicit links between high school mathematics and university STEM applications. For researchers, the study identifies a need for validation studies, expert review, classroom piloting, and longitudinal evidence. The proposed curriculum is therefore best understood as a carefully justified design recommendation that requires further empirical testing before large-scale adoption.

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APPENDIX A. QUESTIONNAIRE

This questionnaire aims to investigate the knowledge and key topics of the scientific mathematics curriculum in secondary education that are essential for students enrolled in first-cycle (Bachelor's) study programs in the following fields: Mathematics, Informatics, Physics, Engineering, Business Informatics, Computer Science, Data Science, and related disciplines. The questionnaire is intended for students currently enrolled in these study programs at either the first (Bachelor's) or second (Master's) cycle of higher education. Students in the first cycle are expected to be in their second or third year of study, ensuring that they have already completed the core or foundational mathematics courses relevant to their field.

1. Basic Information about the Student

1.1. University you are affiliated with:

Fan S. Noli University, University of Tirana, Polytechnic University of Tirana, Aleksander Xhuvani" University, Epoka University, New York University of Tirana, Logos University College, Aleksander Moisiu" University, Ismail Qemali University, Luigj Gurakuqi University, Eqrem Çabej University, Albanian University, European University of Tirana, Polis University.

University of Cambridge, University of Oxford, RWTH Aachen University, Sorbonne University, Delft University of Technology, Eindhoven University of Technology, ETH Zurich, Technical University of Munich, Polytechnic of Milano, Polytechnic of Torino, Sapienza University of Roma, Aristotle University, Kapodistrian University of Athens.

1.2. Which study program are you currently enrolled in or have completed:

Mathematics, Informatics, Physics, Mathematics-Informatics, Mathematics-Physics, Business Informatics, Engineering, Data Science, Computer Science, Information Technology, other (STEM program).

2. Basic Information on Mathematics in the Scientific Curriculum of Secondary Education

This section presents a questionnaire consisting of five questions, designed to obtain general information on the scientific mathematics curriculum in secondary education, in relation to its alignment with the requirements of mathematics courses in first-cycle (Bachelor's) study programs within the aforementioned fields. The questions aim to provide an overall evaluation of:
1. The overall level of the curriculum topics.
2. The adequacy of the total number of mathematics instructional hours.
3. The sequencing of topics across chapters.
4. The coherence and progression of topics across grades and educational levels.
5. The overall sufficiency of the curriculum topics.

For each of the following five questions, please mark only one of the provided options (from 1 to 5), where:

1. *Strongly Disagree* 2. *Disagree* 3. *Neutral* 4. *Agree* 5. *Strongly Agree*

2.1. The level of the mathematics program in the scientific curriculum of secondary education meets the requirements of mathematics courses in first-cycle (Bachelor's) study programs in the respective fields.

1	2	3	4	5

2.2. The total number of mathematics instructional hours in the scientific curriculum of secondary education is sufficient, in relation to the topics covered (and those that may be missing), to meet the requirements of mathematics courses in first-cycle (Bachelor's) study programs in the respective fields.

1	2	3	4	5

2.3. The sequencing of mathematics topics within the chapters of secondary education textbooks is clear and pedagogically justified in terms of the progressive development of knowledge.

1	2	3	4	5

2.4. The development of mathematical concepts and topics in the scientific curriculum of secondary education is appropriately aligned with the respective grade level and stage of schooling.

1	2	3	4	5

2.5. The mathematical concepts and knowledge included in the scientific curriculum of secondary education are sufficient in relation to the requirements of mathematics courses in first-cycle (Bachelor's) study programs in the respective fields.

1	2	3	4	5

2.6. Please briefly provide a comment on your overall evaluation of the mathematics program in the scientific curriculum of secondary education, in relation to its alignment with the requirements of mathematics courses in first-cycle (Bachelor's) study programs in the respective fields.

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3. Information on Mathematics Topics in the Scientific Curriculum of Secondary Education

This section presents a questionnaire concerning the main topics of mathematics, examining whether they are included in the curriculum in the scientific curriculum of secondary education.

The following section presents nine groups of questions corresponding to the main mathematical disciplines that are part of the secondary education curriculum. The same set of questions formulated for Arithmetic is equivalently applied to the remaining mathematical disciplines.

(Arithmetic, Algebra, Plane Geometry, Analytic Geometry, Solid Geometry, Trigonometry, Mathematical Analysis, Probability and Statistics, Discrete Mathematics)

3.1. Arithmetic

Within the discipline of Arithmetic, all concepts, knowledge, and operations encompassed by arithmetic are taken into consideration.

3.1.1. The level of knowledge in Arithmetic within the scientific curriculum of secondary education is appropriate.

1	2	3	4	5

3.1.2. The total number of instructional hours allocated to Arithmetic in the scientific curriculum of secondary education is sufficient in relation to the topics covered (and those that may be missing).

1	2	3	4	5

3.1.3. The sequencing of Arithmetic topics in the scientific curriculum of secondary education is clear and pedagogically justified in terms of the progressive development of knowledge.

1	2	3	4	5

3.1.4. Arithmetic topics in the scientific curriculum of secondary education should primarily be developed in:

Grade 10, First Instructional Period	Grade 10, Second Instructional Period	Grade 10, Third Instructional Period
Grade 11, First Instructional Period	Grade 11, Second Instructional Period	Grade 11, Third Instructional Period
Grade 12, First Instructional Period	Grade 12, Second Instructional Period	Grade 12, Third Instructional Period

3.1.5. The concepts and knowledge of Arithmetic in the scientific curriculum of secondary education are sufficient.

1	2	3	4	5

3.1.6. Please briefly provide a comment on your overall evaluation of the Arithmetic program within the scientific curriculum of secondary education.

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APPENDIX B. DETAILED SUBJECT-LEVEL RESPONSE DISTRIBUTIONS

The following tables retain the five-point response distributions used to calculate the aggregated values reported in the Findings section.

Appendix Table B1
The level of knowledge is appropriate (%)

Subject	1	2	3	4	5
Arithmetic	7.6	18.4	46.6	22.8	4.6
Algebra	14.2	16.2	47.2	15.2	7.2
Plane Geometry	8.1	13.2	40.2	32.9	5.6
Trigonometry	11.7	13.6	37.8	30.7	6.2
Analytic Geometry	11.4	12.9	33.4	38.5	3.8
Solid Geometry	7.8	21.7	50.6	18.6	1.3
Calculus	4.6	12.9	49.2	31.1	2.2
Discrete Mathematics	18.9	13.4	54.4	11.4	1.9
Probability and Statistics	17.3	18.6	40.9	22.1	1.1

Note. 1 = strongly disagree; 2 = disagree; 3 = neutral; 4 = agree; 5 = strongly agree.

Appendix Table B2
The number of instructional hours is sufficient (%)

Subject	1	2	3	4	5
Arithmetic	6.6	20.4	54.6	15.8	2.6
Algebra	9.8	7.8	38.4	36.4	7.6
Plane Geometry	10.2	18.2	58.2	9.2	4.2
Trigonometry	10.2	11.8	50.2	19.6	8.2
Analytic Geometry	11.4	29.2	48.2	6.4	4.8
Solid Geometry	9.6	28.4	40.6	11.8	9.6
Calculus	9.2	32.2	41.6	13.8	3.2
Discrete Mathematics	20.4	29.6	38.4	7.4	4.2
Probability and Statistics	16.8	40.2	31.4	7.8	3.8

Note. 1 = strongly disagree; 2 = disagree; 3 = neutral; 4 = agree; 5 = strongly agree.

Appendix Table B3
The sequencing of topics is logical and pedagogically justified (%)

Subject	1	2	3	4	5
Arithmetic	10.2	16.4	40.8	25.8	6.8
Algebra	6.2	20.4	36.2	30.4	6.8
Plane Geometry	6.4	38.2	30.2	21.4	3.8
Trigonometry	9.2	30.2	50.2	9.2	1.2
Analytic Geometry	13.4	25.4	54.2	5.2	1.8
Solid Geometry	10.8	22.8	39.4	20.6	6.4
Calculus	14.8	28.2	38.6	16.2	2.2
Discrete Mathematics	13.4	38.4	33.6	9.4	5.2
Probability and Statistics	19.2	39.4	32.3	6.4	2.7

Note. 1 = strongly disagree; 2 = disagree; 3 = neutral; 4 = agree; 5 = strongly agree.

Appendix Table B4
The concepts and knowledge are sufficient (%)

Subject	1	2	3	4	5
Arithmetic	14.2	18.6	50.8	14.2	2.2
Algebra	8.8	16.4	39.4	30.2	5.2
Plane Geometry	10.4	24.6	30.4	22.2	12.4
Trigonometry	12.2	20.6	60.2	5.4	1.6
Analytic Geometry	18.2	34.2	41.8	1.6	4.2
Solid Geometry	8.4	20.2	30.2	34.4	6.8
Calculus	13.4	28.6	42.2	12.2	3.6
Discrete Mathematics	19.2	32.2	42.4	4.4	1.8
Probability and Statistics	17.2	37.8	34.2	8.4	2.4

Note. 1 = strongly disagree; 2 = disagree; 3 = neutral; 4 = agree; 5 = strongly agree.

APPENDIX C. TOPIC DESCRIPTIONS PROVIDED TO RESPONDENTS

Arithmetic: Sets; relations; functions; elements of number theory; numeral systems; linear Diophantine equations; decimal numbers.

Algebra: Number operations; algebraic expressions; factoring; ratios and proportions; percentages; powers and roots; scientific notation; logarithms; equations; systems of equations; quadratic, cubic, and quartic equations; polynomials; sequences; progressions; matrices; determinants.

Plane Geometry: Basic geometric concepts; lines and angles; triangles; quadrilaterals; polygons; circles; area and perimeter; geometric transformations.

Trigonometry: Trigonometric functions; properties; equations and inequalities; identities; inverse trigonometric functions; applications in triangles; transformations and graphs.

Analytic Geometry: Cartesian coordinates; distance and midpoint; equations of lines; parallelism and intersections; circles and conic sections; coordinates in space; lines and planes in space; point-line-plane distances; analytic forms of surfaces.

Solid Geometry: Points, lines, and planes in space; relationships between lines and planes; perpendicularity; polyhedral, prisms, pyramids, cylinders, cones, and spheres; surface area and volume; sections and projections.

Calculus: Functions and graphs; limits; continuity; differentiation; applications of derivatives; definite and indefinite integrals; methods and applications of integration; introductory functions of several variables.

Discrete Mathematics: Combinatorics; principles of mathematical reasoning; recurrences; complex numbers; inequalities; sums and products.

Probability and Statistics: Probability rules; compound and conditional probability; independence; random variables and distributions; expectation, mean, and variance; binomial, uniform, and normal distributions; descriptive statistics; data displays; introductory statistical inference.