



INTEGRATING DIGITAL TECHNOLOGIES INTO CAMBRIDGE A LEVEL MATHEMATICS: A STEAM- BASED APPROACH TO DEVELOPING STUDENTS' DIGITAL LITERACY

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Annotation. The growing use of digital technologies in mathematics education highlights the need to develop students' digital literacy alongside their mathematical knowledge and problem-solving skills. In Presidential Schools in Uzbekistan, Cambridge International A Level Mathematics courses emphasize mathematical reasoning and the presentation of worked solutions, whereas digital examinations such as the Digital SAT require students to interact effectively with digital testing environments and technological tools. This difference creates an opportunity to integrate digital technologies more systematically into A Level mathematics teaching. This study aims to examine the potential of selected digital learning platforms, including College Board resources, Save My Exams, and Desmos, and to propose a STEAM-based framework for their integration into A Level Mathematics lessons. The comparative analysis focuses on curriculum alignment, opportunities for independent practice, mathematical visualization, feedback, and the development of digital problem-solving skills. The proposed framework seeks to connect conceptual mathematical understanding with purposeful technology use while preserving the emphasis on rigorous mathematical reasoning and worked solutions. The study offers practical recommendations for integrating digital resources into mathematics education and identifies directions for further empirical investigation of their contribution to students' digital literacy.

Keywords: STEAM education, digital literacy, Cambridge A Level Mathematics, educational technology, digital learning platforms, mathematical visualization, digital problem-solving, technology integration.

Introduction. The integration of digital technologies into secondary education has become an important consideration in preparing students for contemporary academic and professional environments. Digital literacy extends beyond the ability to operate digital devices; it also involves accessing, evaluating, interpreting, and creating information through digital technologies. In educational settings, these competencies can support independent learning, problem-solving, information analysis, and the effective use of digital resources. UNESCO emphasizes the importance of developing digital competencies and integrating technology purposefully into teaching and learning processes. Consequently, mathematics education provides a relevant context for examining how digital tools can be incorporated into subject teaching to support both mathematical understanding and students' digital literacy.

Cambridge International A Level Mathematics provides a rigorous framework for developing mathematical reasoning, analytical thinking, and systematic problem-solving. The syllabus covers areas such as pure mathematics, mechanics, and probability and statistics, depending on the selected course route. Assessment requires students to demonstrate

mathematical knowledge and communicate their reasoning through structured solutions to mathematical problems. This approach encourages students to understand mathematical procedures, justify intermediate steps, and apply concepts to unfamiliar problems. However, the effective use of digital technologies in mathematics learning involves additional competencies, including interpreting digital representations, manipulating mathematical objects using software, evaluating computational outputs, and selecting appropriate digital tools for specific tasks.

The relevance of these competencies becomes particularly apparent when the assessment requirements of Cambridge A Level Mathematics are considered alongside those of the Digital SAT. The Digital SAT is administered through the Bluebook application, which provides students with an integrated set of testing tools, including a Desmos calculator, a reference sheet, question navigation, and options for marking questions for review [3]. Students therefore need to become familiar not only with mathematical content but also with the digital environment in which they encounter and solve problems. Although Cambridge A Level Mathematics and the Digital SAT differ in their curricula, assessment structures, and purposes, comparing their learning and assessment contexts can help identify opportunities to strengthen students' digital readiness within existing mathematics courses.

This issue is particularly relevant to mathematics teaching in Presidential Schools in Uzbekistan, where Cambridge International programmes are implemented. In the educational context considered in this study, Digital SAT Mathematics is not delivered as a separate, structured course within the existing school programme. Consequently, A Level Mathematics lessons may provide an opportunity to develop selected digital competencies alongside the prescribed mathematical content. Rather than replacing established teaching methods or converting A Level lessons into SAT preparation sessions, digital technologies can be integrated into existing mathematical activities to enrich visualisation, support independent practice, encourage verification of solutions, and familiarise students with digital mathematical tools.

The aim of this study is to analyse selected digital learning platforms and propose a framework for integrating digital technologies into Cambridge A Level Mathematics teaching to support the development of students' digital literacy. The analysis focuses on the platforms' alignment with mathematical learning objectives, opportunities for independent practice, support for mathematical visualisation, and potential to develop digital problem-solving skills.

Methods. This study adopts a qualitative, descriptive-comparative research design to examine the potential integration of digital technologies into Cambridge International A Level Mathematics teaching. The study is situated in the context of upper-secondary mathematics education in Presidential Schools in Uzbekistan, where students in Grades 10 and 11 study advanced mathematics through a structured curriculum that emphasizes mathematical reasoning, problem-solving, and the presentation of worked solutions.

The research focuses on three digital resources with complementary educational functions: College Board resources for the Digital SAT, Save My Exams for syllabus-aligned revision and examination practice, and Desmos for interactive mathematical visualization. These resources were selected because they represent different dimensions of technology-supported mathematics learning: digital assessment readiness, structured independent practice, and mathematical exploration.

The study does not assume that the three platforms are interchangeable or that their use necessarily improves learning outcomes. Instead, it examines their documented functions and considers how these functions may support specific learning objectives within an existing A Level Mathematics course. The analysis is intended to inform the design of a technology-integration framework rather than to establish causal relationships between platform use and student achievement.

The analysis is based on publicly available documentation describing the functions and educational resources of the selected platforms. The primary sources include official College Board information about the Bluebook digital testing environment, Save My Exams materials relevant to Cambridge A Level Mathematics, and the Desmos graphing calculator and its mathematical visualization functions.

A structured comparative approach is used to examine the platforms according to six criteria:

1. Curriculum alignment: the extent to which the resource can support the mathematical topics and learning objectives of Cambridge A Level Mathematics.
2. Independent practice: the availability of resources that enable students to practise mathematical procedures and review their understanding.
3. Mathematical visualization: the capacity to represent functions, relationships, and mathematical concepts dynamically or graphically.
4. Feedback and solution analysis: the extent to which students can check their work, examine solutions, or identify errors.
5. Digital literacy development: the opportunities provided for students to use digital tools purposefully, interpret digital representations, and solve problems in a digital environment.
6. Classroom integration: the potential to incorporate the resource into existing lessons without replacing the mathematical reasoning and written solution methods required by the course.

The comparison is based on the documented functions of each resource. It does not constitute an independent usability test or a direct measurement of student learning. Where a platform provides a function that differs from those of the other platforms, this difference is considered in relation to its intended instructional role rather than interpreted as evidence of overall superiority.

Results. The proposed framework aims to integrate digital technologies into Cambridge International A Level Mathematics without changing the fundamental learning objectives of the existing curriculum. It is based on the assumption that students' digital literacy can be supported through purposeful engagement with digital tools during mathematical investigation, independent practice, and solution verification.

The framework follows four principles. First, curriculum alignment ensures that digital activities support the mathematical concepts being taught rather than introducing unrelated technological tasks. Second, complementarity preserves the role of conventional mathematical reasoning and worked solutions while using digital resources to extend learning opportunities. Third, active engagement requires students to interpret, test, and explain mathematical results instead of merely observing digital outputs. Fourth, reflective use of technology encourages students to evaluate the reliability and limitations of digital tools and to justify their mathematical conclusions independently.

Within this framework, STEAM is understood as an approach that connects mathematical knowledge with technological exploration and, where appropriate, practical or interdisciplinary problems. The use of a digital application alone is not considered sufficient to establish a STEAM learning activity. The activity should have a clear mathematical objective and require students to investigate relationships, interpret representations, or apply knowledge to a meaningful problem.

The framework can be implemented through activities connected to topics commonly taught in A Level Mathematics. Table 2 presents illustrative examples of how digital resources may be integrated into lessons. The examples are proposed instructional applications rather than outcomes of a completed classroom experiment.

Table 1. Proposed integration of digital technologies into selected A Level Mathematics topics.

A Level Mathematics topic	Digital resource	Proposed student activity	Targeted digital competency
Functions and transformations	Desmos	Manipulate parameters and compare changes in graphical and algebraic representations	Digital tool proficiency and interpretation of digital representations
Equations and inequalities	Desmos	Compare algebraic solutions with graphical intersections and verify the number of solutions	Digital problem-solving and verification
Probability and statistics	Spreadsheet software	Organize data, construct charts, and interpret numerical summaries	Data literacy and digital content creation
Mixed examination practice	Save My Exams	Complete topic-based questions, review worked solutions, and identify differences between personal and model solutions	Independent digital learning and error analysis
Digital assessment preparation	College Board resources	Examine selected digital mathematics tasks and practise using available testing tools	Digital assessment readiness and digital problem-solving
Probability and statistics	Spreadsheet software	Organize data, construct charts, and interpret numerical summaries	Data literacy and digital content creation

A Lesson-Level Integration Sequence

To support consistent classroom implementation, the framework proposes a four-stage lesson sequence.

Stage 1: Mathematical introduction. The teacher introduces the learning objective, explains the relevant mathematical concepts, and demonstrates the expected solution method. Students are encouraged to record key steps and explain the reasoning behind them.

Stage 2: Digital exploration. Students use an appropriate digital tool to explore a mathematical relationship, visualize a concept, or investigate a conjecture. The teacher provides guiding questions that require students to interpret the results rather than simply reproduce them.

Stage 3: Independent practice and verification. Students solve related problems independently and use digital resources to check selected results or compare alternative approaches. Where worked solutions are available, students analyse the differences between their own methods and the presented solutions.

Stage 4: Reflection and mathematical justification. Students explain what they learned from the digital activity, identify the limitations of the tool used, and present a mathematically justified conclusion. This stage reinforces the distinction between obtaining an answer computationally and demonstrating why that answer is valid.

The proposed sequence is intended to integrate digital tools into the existing teaching process rather than create a separate technology-focused lesson for every mathematical topic. Its application can be adapted to the complexity of the subject matter, the students' prior experience, and the time available.

The development of digital literacy requires observable indicators that can be assessed systematically. For the proposed framework, five dimensions are suggested: appropriate selection of digital tools, effective use of digital functions, interpretation of digital representations, verification of computational outputs, and independent problem-solving.

These dimensions can be assessed through classroom observation, analysis of student work, short performance-based tasks, and structured reflection. For example, students may be asked to solve a mathematical problem, verify their result using a graphing tool, explain any discrepancy between the two methods, and justify their final answer. Such a task allows the teacher to examine both mathematical understanding and the purposeful use of technology.

A possible assessment rubric could distinguish between emerging, developing, and proficient performance. At the emerging level, a student may require substantial guidance to operate a tool or interpret its output. At the developing level, the student may use the tool appropriately but provide limited explanation of the results. At the proficient level, the student may select a suitable tool independently, interpret its output critically, verify the result mathematically, and explain the limitations of the digital method.

Discussion. The comparative analysis indicates that the selected digital platforms can serve complementary functions in Cambridge International A Level Mathematics teaching. Rather than treating one platform as a complete solution, teachers can combine their respective features to support mathematical understanding, independent learning, and students' ability to work confidently in digital environments. College Board resources provide opportunities to become familiar with digital assessment tools and task formats, Save My Exams supports

syllabus-related revision and the analysis of worked solutions, and Desmos facilitates the visual exploration of mathematical relationships.

The potential value of this combination lies in the relationship between mathematical reasoning and purposeful technology use. For example, when studying functions and their transformations, students can first solve a problem algebraically, then use Desmos to investigate how changes in parameters affect the graph, and finally explain whether the graphical observations are consistent with their analytical results. Such a sequence encourages students to move between symbolic and graphical representations rather than relying exclusively on one method. It also provides opportunities to practise selecting appropriate digital tools, interpreting visual information, and checking mathematical conclusions.

A STEAM-based approach can strengthen this integration when digital activities are connected to meaningful mathematical questions and, where appropriate, real-world contexts. For instance, statistical data can be organized and analysed using spreadsheet software, while graphical tools can help students explore mathematical models and interpret their behaviour. However, the presence of technology alone does not make an activity genuinely interdisciplinary. Teachers should establish a clear learning objective and ensure that students understand the relationship between the mathematical concept, the digital tool, and the problem being investigated.

The proposed framework also addresses a potential tension between digital exploration and the written mathematical reasoning emphasized in Cambridge A Level Mathematics. Digital tools can make patterns and relationships easier to investigate, but they should not replace analytical methods, derivations, or the presentation of complete solutions. A balanced lesson sequence should require students to use technology to explore or verify a result and then provide a mathematically justified explanation. This principle helps preserve the academic demands of A Level Mathematics while creating opportunities for digital competence development.

Future research could evaluate the framework through classroom-based implementation in Grades 10-11. Such research could use a validated digital literacy assessment, structured classroom observations, student work analysis, and interviews or questionnaires. Where feasible, researchers could compare students' performance before and after implementation or examine differences between groups following clearly defined instructional approaches. This would help establish whether the proposed integration contributes to measurable changes in digital competence and mathematical learning.

Conclusion and Recommendations

This study examined the potential roles of College Board digital assessment resources, Save My Exams, and Desmos in Cambridge International A Level Mathematics teaching and proposed a STEAM-based framework for their purposeful integration. The analysis suggests that these resources offer different, potentially complementary functions: digital assessment familiarization, structured revision and worked-solution analysis, and interactive mathematical visualization. Their educational value depends on how teachers connect these functions to curriculum objectives and students' mathematical activities.

For classroom implementation, teachers are encouraged to select digital resources according to specific learning objectives rather than use technology for its own sake. Desmos can be incorporated into topics involving functions, transformations, equations, and curve

sketching; Save My Exams can support targeted revision and the review of worked solutions; and College Board resources can provide supplementary familiarity with the Digital SAT environment. Where statistical analysis or data-handling tasks are appropriate, spreadsheet software may extend the framework to include data literacy and digital content creation.

In conclusion, integrating digital technologies into Cambridge A Level Mathematics offers a practical opportunity to connect rigorous mathematical learning with the digital competencies increasingly required in contemporary education. A carefully designed STEAM-based approach may help teachers develop these competencies within existing mathematics lessons while maintaining the subject's emphasis on reasoning, precision, and independent problem-solving.

Recommendations for future practice and research:

1. Integrate digital tools into existing A Level Mathematics topics through clearly defined learning objectives.
2. Combine digital exploration with written solutions, mathematical explanations, and independent verification.
3. Develop and validate a rubric for assessing digital problem-solving in mathematics lessons.
4. Conduct classroom-based studies to examine changes in students' digital literacy and mathematical performance.
5. Investigate implementation factors, including teacher readiness, access to devices, and the suitability of digital resources for different mathematical topics.

References:

1. Cambridge International Education. (n.d.). *Cambridge International AS & A Level Mathematics* (9709). <https://www.cambridgeinternational.org/programmes-and-qualifications/cambridge-international-as-and-a-level-mathematics-9709/>
2. Cambridge International Education. (2025). *Cambridge International AS & A Level Mathematics 9709 syllabus for examination in 2026 and 2027*. <https://www.cambridgeinternational.org/Images/697427-2026-2027-syllabus.pdf>
3. College Board. (n.d.). *Bluebook testing tools*. <https://bluebook.collegeboard.org/students/tools>
4. College Board. (n.d.). *Full-length digital practice tests on Bluebook*. <https://satsuite.collegeboard.org/practice/practice-tests/bluebook>
5. Desmos Studio PBC. (n.d.). *Desmos graphing calculator*. <https://www.desmos.com/calculator>
6. Hillmayr, D., Ziernwald, L., Reinhold, F., Hofer, S. I., & Reiss, K. M. (2020). The potential of digital tools to enhance mathematics and science learning in secondary schools: A context-specific meta-analysis. *Computers & Education*, 153, Article 103897. <https://doi.org/10.1016/j.compedu.2020.103897>
7. Martín-Cudero, D., Cid-Cid, A. I., & Guede-Cid, R. (2024). Analysis of mathematics education from a STEAM approach at secondary and pre-university educational levels: A systematic review. *Journal of Technology and Science Education*, 14(2), 507–528. <https://doi.org/10.3926/jotse.2349>

8. Msafiri, M. M., Kangwa, D., & Cai, L. (2023). A systematic literature review of ICT integration in secondary education: What works, what does not, and what next? *Discover Education*, 2, Article 44. <https://doi.org/10.1007/s44217-023-00070-x>
9. Save My Exams. (n.d.). *A Level Maths revision notes*. <https://www.savemyexams.com/a-level/maths/revision-notes/>
10. Vuorikari, R., Kluzer, S., & Punie, Y. (2022). *DigComp 2.2: The digital competence framework for citizens—with new examples of knowledge, skills and attitudes*. Publications Office of the European Union. <https://doi.org/10.2760/115376>