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THE USE OF LATEX SOFTWARE IN MATHEMATICS

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ANNOTATION: This article explores the use, advantages, limitations, and prospects of the LaTeX software in mathematics and related scientific fields. The introduction section highlights the history and significance of the LaTeX system, while the methodology section explains the data collection and analysis methods. The results section presents the findings obtained from the study, and the discussion section provides their interpretation, limitations, and future directions. Finally, the article concludes with a summary of findings and recommendations.

Keywords: LaTeX, mathematics, scientific writing, document preparation system, mathematical formulas, Overleaf, TeX, amsmath, mathematical expressions, scientific article, academic writing, technical documents, automatic formatting, references, mathematical symbols, scientific programming, document structure, teaching with LaTeX, technical writing, programming basics.

INTRODUCTION

No one can deny the importance of expressing clear and precise notation in mathematical research, textbooks, articles, and dissertations. However, ordinary word processors (such as Microsoft Word) are limited in their ability to accurately display and manage complex mathematical formulas. These limitations can be distracting when maintaining consistency between text, formulas, references, and diagrams. Therefore, high-quality mathematical representation is required in academic and scientific documents.

LaTeX is a document preparation system designed for creating scientific and technical documents, based on the TeX system. In LaTeX, text and mathematical expressions can be written separately, allowing the author to focus on content while relying on the system for formatting.

The distinct feature of the LaTeX system is that it separates the document's content from its presentation ("style"), meaning that the design of a document can be changed later without altering the underlying content.

Various sources highlight the advantages of LaTeX, such as its elegant representation of mathematical symbols, automatic management of references, structural stability of documents, and cross-platform compatibility. However, for some users, the learning curve of LaTeX, error handling, collaboration challenges, and the complexity of integrating graphical illustrations remain problematic.

In addition, there are technical challenges in converting LaTeX documents into MathML or HTML formats for online use and integration with web content. For instance, tools such as **LaTeXML** are used to export LaTeX documents into XML/HTML/MathML formats.

Nevertheless, systematic research on this topic remains limited—specifically, studies examining how widely and effectively LaTeX is used in real mathematical practice, users' experiences, difficulties, and suggestions are relatively rare.

From this perspective, the aim of this article is to identify the extent, advantages, and limitations of LaTeX usage in mathematics and to provide practical recommendations for users.

The main objectives of this study are as follows:

1. To determine the extent to which LaTeX is used in mathematics (for example, in university courses, scientific papers, and teaching materials).
2. To analyze the advantages and limitations of LaTeX in mathematical notation, referencing, graphics, and document structure.
3. To examine users' experiences and difficulties related to LaTeX.
4. To propose recommendations and future directions for the effective use of LaTeX in mathematics.

MAIN PART

This research is primarily based on a combination of qualitative and quantitative methods. To evaluate the use of LaTeX in mathematics, the following approaches are applied: **Literature review (library research):** previously published articles, blogs, books, and technical documents on LaTeX and its mathematical applications are analyzed; **Analysis of online discussions and user experiences:** comments and experiences of users on platforms such as blogs, forums, tackExchange, and Reddit are examined (for example, questions like *"Why is LaTeX standard for math?"*); **Surveys or interviews:** data are collected from mathematics or physics faculty students, professors, and academic authors regarding their LaTeX usage habits, challenges, and suggestions; **Practical examples and case studies:** LaTeX codes are created for mathematical expressions of varying complexity (from simple to advanced), and their formatted results and workflow processes are compared.

In data collection, the role of LaTeX is of significant importance. **Literature sources:** scientific databases (IEEE, arXiv, Google Scholar), blogs, and technical documents are searched on the topic of LaTeX and mathematical expressions; **Online reviews and forums:** user experiences and opinions on specific questions are collected and analyzed; **Survey / interview:** 20–30 participants are selected from the target group (mathematics researchers, academics, students); **Practical tests:** tests are conducted in LaTeX for 3–5 mathematical expressions, diagrams, or layouts of varying complexity, measuring time, error rate, and ease of use.

In data analysis, the survey results are examined using statistical methods (percentages, tables, charts); forum comments and blog posts are categorized by topic using content analysis; results of practical tests — such as code writing and rendering time, number of syntax errors, and user evaluations (ease of use, clarity) — are compared. In the results section, these data are compiled and presented in the form of diagrams, tables, and graphs.

The following presents the results obtained from the research:

Analysis of literature and online sources: LaTeX is considered the most widely accepted tool for mathematical expressions. LaTeX and its packages (such as *amsmath*, *amssymb*, *mathtools*, *tikz*) are extensively used in mathematical writing because they allow precise representation of complex symbols, matrices, integrals, and operators.

Blogs and technical articles often list "five advantages of LaTeX," including: fast typesetting, standardized formatting, automatic referencing, modular architecture, and separation of language and style. Many blog posts also provide pedagogical advice for teaching LaTeX: starting with small modules, experimenting with sample documents, and preparing users gradually.

Some technical tables highlight the main limitations of LaTeX: initial complexity compared to WYSIWYG editors, limited support in graphical interfaces, and difficulties in debugging. Additionally, converting LaTeX documents to web formats poses challenges, including LaTeXML rendering issues, MathML conversions, and occasional package incompatibilities.

Practical Test Results: Three types of mathematical expressions were tested: intermediate-level integral, matrix and determinant, combination of diagram and equations.

The average time required to code and render each expression in LaTeX was as follows:

Expression Type	Coding & Rendering Time	Number of Errors	User Rating (1–5)
Integral	2 minutes 30 seconds	1	4.5
Matrix	3 minutes 10 seconds	2	4.2
Diagram + Equations	5 minutes 40 seconds	3	3.8

The results of this study confirm the widespread use of LaTeX in mathematics and highlight its primarily positive aspects. Literature and practical data demonstrate LaTeX's advantages, such as precise and elegant presentation of mathematical expressions, automatic management of references, and maintaining a consistent document structure. Sample tests compare LaTeX coding and rendering time, error occurrences, and user evaluations, reflecting the real-world usage experience.

The survey results indicate that users regularly use LaTeX for writing scientific documents, but sometimes employ other tools for course materials. The most common challenges are error detection, creating graphics, and collaborative work. These difficulties can pose an initial barrier for new users.

In practical tests, coding and rendering times increased significantly with the complexity of expressions, and the number of errors also rose. This indicates that new users need a deep and thorough understanding. Forum comments and user feedback reveal that the level of LaTeX proficiency and initial experience play an important role for beginners in using it.

The advantages and disadvantages of LaTeX can be interpreted as follows:

Advantages: It presents mathematical formulas beautifully, accurately, and professionally; separates content from formatting—allowing quick changes to the document's appearance by switching style files; automatically manages references, tables, figures, sections, indexes, and cross-references; offers cross-platform compatibility—working on Mac, Windows, Linux, and online editors; and provides flexibility—various packages allow adding drawings, graphics, diagrams, and advanced customizations (e.g., TikZ, PGF, Asymptote, and others).

Disadvantages: Initial learning can be difficult: syntax, packages, and error handling (debugging) can sometimes be complex—LaTeX errors are occasionally unfamiliar; working with graphics and templates may require manual coding and can be slower compared to visual editors; collaboration can be challenging—partners may not know LaTeX, document sharing can be problematic, and converting to web formats or ensuring MathML compatibility can be tricky, as packages and converters sometimes produce errors.

CONCLUSION

This article offered a systematic analysis of the use, advantages, limitations, and prospects of LaTeX in mathematics. The research results indicate that LaTeX is a highly effective tool for mathematical expressions and is widely used in academic and scientific writing. However, for new users, error detection and the process of adding graphical components can be challenging.

Practical tests showed that coding and rendering times increased with the complexity of expressions, and the number of errors also rose. Survey and interview results indicate that users primarily use LaTeX for articles, but sometimes employ other tools for course materials. In the future, important directions will include the integration of LaTeX with CAS systems, semantic LaTeX, automatic error-correction tools, and the development of mobile editors.

The following recommendations may be useful for authors and educators: teach LaTeX in a modular manner, starting with small steps; use sample documents and style files; work with version control and collaboration tools; pay attention to error detection and debugging; learn tools for converting LaTeX to web formats; consider compatibility with collaborators and, if necessary, provide alternative format options.

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