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Diachronic Analysis of Undergraduate Project Titles in Mathematics Education

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Abstract
This study analyzed undergraduate mathematics project titles in Algebra and Geometry at St. Francis College of Education, Hohoe, from 2007 to 2021. The purpose was to explore diachronic trends in project title frequency, word count, and average length to understand research focus and academic communication practices in mathematics education. The population comprised approximately 1000, while only 834 project titles were sampled, with 415 Algebra-related and 419 Geometry-related titles. A convenience sampling technique was used to select the dataset. An analytic quantitative research design was employed, utilizing descriptive and trend analyses to evaluate the data. The study revealed a fluctuating yet overall increase in the number of project titles over time, with variations in average title length. Algebra titles averaged shorter word counts than Geometry titles, reflecting differences in disciplinary focus. The average length for Algebra titles was 19.47 words (in 2007-2017) compared to 22.12 words (in 2018-2021), whereas in Geometry, the average title length slightly decreased from 22.17 words (in 2007-2017) to 20.55 words (in 2018-2021). The results indicate a growing emphasis on technical precision in Algebra and conceptual depth in Geometry. The study concludes that there is not much difference in student project titles construction after a decade in both Algebra and Geometry related titles. It is recommended that lecturers should guide students on project topic construction to meet current practices.

Keywords: Project work titles, Algebra-related, Geometry-related, Average length of titles

Introduction

Project work writing constitutes a vital component of undergraduate studies in Ghanaian tertiary institutions, particularly for students in mathematics education. The process involves formulating a research topic, planning and conducting an investigation, and reporting findings in a dissertation. Duff (2010) argued that such discourse facilitates the completion of academic programs and initiates students into the academic discourse community. For undergraduate mathematics students, project work writing serves as an avenue for engaging with and contributing to the discipline's knowledge base, particularly in specialized fields such as Algebra and Geometry. Titles are integral to the project work process, as they serve as the primary point of interaction between the research work and its audience. Archibald (2017) highlights the rhetorical importance of titles, describing them as a device common to all academic disciplines. Yang (2024). Emphasize that a title captures the research content and signals the intended audience. The title's informativeness and attractiveness significantly influence whether a research work garners attention and readership. In mathematics, project titles in Algebra and Geometry must concisely communicate the research's scope while appealing to readers with an interest in mathematical problem-solving or pedagogy.

Titles must be both informative and attractive, impacting not just readership but also citation rates (Edwards & Ward, 2004). Informative titles in mathematics dissertations might specify the mathematical theories applied, the educational context, or the problems addressed. The growing academic focus on titles has given rise to a field of study referred to as "titleology" (Bérubé et al., 2018). Studies in this area have explored titles from various perspectives, including intra-disciplinary, inter-disciplinary, and diachronic analyses. Akoto (2018) examined titles of dissertations from a Ghanaian university and found notable differences between disciplines. The study revealed that Literature project works or titles were generally simpler and utilized more punctuation than Chemistry titles. This variability could extend to mathematics dissertations, where titles in Algebra might

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prioritize technical precision, while those in Geometry could emphasize visualization or conceptual understanding. Buxton and Meadows (1977) indicate that titles in scientific fields, including mathematics, have become increasingly substantive and informative over time. This trend aligns with the growing specialization within subfields like Algebra and Geometry. For example, a title such as "*Analyzing Symmetry Groups in High-Dimensional Geometry for Curriculum Development*" reflects both technical depth and educational relevance, which are crucial in mathematics education.

Undergraduate project titles in mathematics serve as windows into students' academic interests, research trends, and the pedagogical priorities of educational institutions. These titles encapsulate the essence of research themes, methodologies, and the evolving focus of mathematics as a discipline. Understanding the patterns in the areas students most frequently explore and the structural characteristics of these titles, such as their length and specificity, can provide insight into how mathematics education aligns with broader research and societal demands. Mathematics encompasses diverse fields such as algebra, geometry, statistics, analysis, and applied mathematics, with each offering a unique lens for understanding complex systems. Among these, algebra and geometry have traditionally been prominent due to their foundational roles in both pure and applied contexts. It was indicated that students often gravitate towards topics that reflect current trends or challenges in mathematics, such as computational methods, mathematical modeling, and interdisciplinary applications (Sokolowski, 2019). However, the extent to which different subfields dominate undergraduate research remains understudied. Another important dimension of project titles is their linguistic and structural characteristics. Titles play a critical role in conveying the scope and intent of research. For example, shorter titles often prioritize conciseness and impact, while longer titles might include greater detail about the methodology, objectives, or context. Studies analyzing academic titles across disciplines suggest that length and specificity are influenced by trends in research communication, institutional guidelines, and disciplinary norms (Hyland, 2004). In mathematics, where clarity and precision are paramount, examining the length and structure of project titles could reveal how effectively students communicate their research focus.

The diachronic analysis of undergraduate project titles in mathematics, particularly in the areas of algebra and geometry, reflects broader trends in mathematics education and research. These fields have evolved significantly, shaped by both theoretical advancements and practical applications. Algebra is central to modern mathematics education, fostering abstract reasoning and problem-solving skills. Geometry, rooted in spatial reasoning, plays a crucial role in visualizing mathematical relationships and applications in diverse fields. Research trends have demonstrated a growing emphasis on innovative methodologies, computational tools, and interdisciplinary approaches within these domains. Literature indicates a shift in the focus of mathematics education research towards addressing global and contextual challenges, such as equity, inclusivity, and the integration of digital tools (Sokolowski, 2019). Algebra research, for instance, has explored dynamic systems, functional thinking, and real-world applications, while geometry has expanded to include computational geometry and topology (Youvan, 2024). Bibliometric analyses indicate that influential works in these fields are widely distributed across a variety of reputable journals, showcasing the diversity and depth of ongoing scholarly activities (Yadav & Lenka, 2023).

Mathematics education research has been instrumental to the significant changes that have occurred over the blink of an eye to conventional teaching and learning in mathematics over the past few decades (Karadag, 2010). Mathematics education helps train students in abstract thinking and analysis, both of which are important for a modernizing society. Recent Mathematics Education research reviews are shedding some light on the current state of the field, progress, challenges and emerging directions. The increasing number of algebra and geometry titles, fundamental questions remain on characterisation, in research dynamics, and the developmental trajectory of mathematics education in a bibliometric lens. These questions have provoked an academic conversation about how the discipline has developed and where it is going.

In comparison to systematic review papers, bibliometric research uses analytical and statistical methods to explore all published articles, revealing worldwide trends for certain fields. Using citations as a means of indicating the positions of papers, authors, and journals in the academic landscape, this method provides a hierarchical perspective on the influence of publications. This methodology augments the bibliometric citation analysis by allowing quantitative growth evaluation of journal titles, keywords, and academics. Moreover, bibliometric techniques enable the visualization of scholarly networks, illustrating interactions among authors from diverse universities, institutions, and countries. This varied view of academic society not only highlights collaborative trends but also reveals the broader dynamics shaping mathematics education research. As a result, bibliometric analysis serves as a vital tool for comprehensively understanding the field's diachronic development and future directions (Jiang & Zhang, 2024).

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Another critical aspect is the alignment of undergraduate projects with curriculum goals and pedagogical innovations. For example, project-based learning frameworks emphasize the need for students to engage with real-world problems and interdisciplinary approaches, fostering deeper understanding and skill development (Singha & Singha, 2024). This is particularly relevant in the context of algebra and geometry, where traditional topics are being augmented by applications in technology, environmental modeling, and social sciences. Diachronic analysis, a method of examining changes over time, can uncover trends in both the thematic focus and structural composition of undergraduate project titles in mathematics. Such an analysis could address critical questions: What are the most popular aspects of mathematics chosen by students? Do these preferences change over time? How does the length and structure of titles reflect evolving practices in academic communication? Addressing these questions is vital for understanding the trajectory of undergraduate mathematics education and ensuring its alignment with contemporary research and industry demands. By analyzing the areas of focus and the characteristics of project titles, this study aims to contribute to the broader understanding of mathematics education trends and research guidance at the undergraduate level.

Study Context

This study on the analysis of undergraduate project titles in Mathematics highlights the transformative potential of involving undergraduate students in mathematics education research. The findings advocate for expanding research opportunities as a pivotal strategy for improving teaching and learning in mathematics education, especially through innovative and collaborative approaches. This section contextualises the core aspects of the study, emphasizing its contributions, implications, and alignment with prior research. Groth et al. (2020) describe the significance of integrating research opportunities into the undergraduate mathematics education curriculum. The focus on extracurricular and course-embedded experiences aligns with Dennis (2024), who demonstrated that engaging pre-service teachers in authentic research practices enhances their pedagogical content knowledge and confidence in delivering mathematics lessons. Similarly, Makonye (2019) found that undergraduate research develops critical thinking and also fosters a deeper understanding of how children learn mathematical concepts. The study proposes a model grounded in the design-based research (DBR) paradigm, a methodological approach that merges theoretical inquiry with practical application. In the model, pairs of prospective teachers work collaboratively with mentors to design instructional sequences and analyze classroom data. Hoadley and Campos (2022) validated the effectiveness of DBR in educational contexts, particularly for generating actionable insights that inform teaching practices. The collaborative nature of the approach aligns with Vygotsky's social constructivist theory, which emphasizes the role of social interaction in learning and development. The process described in the study equips prospective teachers with the skills to make informed instructional decisions based on qualitative data. Pang (2016) highlighted the importance of developing pedagogical reasoning and decision-making skills in teacher education. By engaging in the analysis of classroom data, prospective teachers gain firsthand experience in identifying and addressing learners' misconceptions, thereby bridging the gap between theory and practice. While the study offers a promising framework, it also highlights potential challenges, such as the need for adequate training in research methods and the time-intensive nature of DBR projects.

There appears to be no unanimous consensus among scholars regarding the appropriate length of research titles, including those in undergraduate projects in mathematics, particularly in Algebra and Geometry. Literature on titles or project topics (Appiah, 2021) reveals both similarities and differences in conclusions about title length. Archibald's (2017) study of 200 research article titles across five academic fields, including Computer Science, Applied Linguistics, and Chemistry, found that Linguistics titles are generally longer than Chemistry titles. The study suggests that research in scientific disciplines, such as mathematics, may favor relatively shorter titles compared to those in the humanities. Haggan (2004), however, offers a contrasting perspective. The study of research article titles in Literature, Linguistics, and Science concluded that Chemistry titles are longer than those in Linguistics and Literature. These discrepancies underscore the variability in title length across disciplines, further substantiated by studies like Appiah's (2021) analysis of Computer Science sub-disciplines, which revealed average title lengths ranging from 8.0 to 9.9 words. When specifically considering mathematics-related project titles, parallels can be drawn to cross-disciplinary study of Literature and Chemistry dissertation titles. They observed that Literature titles, with an average length of 12.8 words, were longer than Chemistry titles, which averaged 10.2 words. This supports the notion that mathematical research titles, particularly aspects like Algebra and Geometry, may tend to be concise due to the technical nature of the discipline and the need for precision. Further, Fumani et al. (2015) demonstrated that title length increases over time, often influenced by factors such as the number of authors and the use of colons and commas. While undergraduate projects in mathematics typically involve a single author, trends observed in academic research may still influence the structure and length of titles, particularly as students are guided by faculty with exposure to broader academic norms.

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In the specific context of Algebra and Geometry, the technical nature of these aspects may lead to shorter, more focused titles. However, the complexity of concepts or methodologies involved may necessitate slightly longer titles, especially when detailing specific research designs or theoretical frameworks. Thomas (2021) assertion that sub-disciplinary variations impact title length, as seen in Food Science poster titles averaging between 14.6 and 15.3 words. While opinions on ideal title length in academic writing vary, the diversity in approaches reflects the evolving nature of title construction across disciplines. Based on this review, it is hypothesized that Algebra and Geometry undergraduate project titles may vary in length, influenced by factors such as the specificity of research focus, methodological, and alignment with disciplinary conventions.

Objectives of the Study

1. To examine diachronic trends in undergraduate project titles in algebra and geometry
2. To evaluate the alignment of undergraduate project titles with the average length of text.
3. To also examine the trend of change after a decade.

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Method and Materials

The study employed an analytic quantitative design. The quantitative approach emphasizes collecting and analysing numerical data by focusing on measuring the scale, range and frequency. The setting for the study is the St. Francis College of Education, Hohoe in Ghana. This choice of setting was made based on the consideration of proximity for data collection and the researchers working in the college. The core mandate of the college is to train teachers for the basic schools within the country. The college runs three main programmes (ECE, Primary Education, Junior High School Education) with specializations in various disciplines like Mathematics/ICT, Science/Mathematics, ICT/Mathematics, Languages, Social Studies, etc. The data for the study were titles of undergraduate project works submitted to the Department of Mathematics and ICT from the year 2007 to 2021. In all, 834 project titles were obtained. There were 415 Algebra-related titles and 419 Geometry related titles. These were conveniently sampled. The convenience sampling, according to Landers and Behrend (2015), involves the use of data that is readily available at a time to save time, effort and money. The data fell within 2007 - 2017 and 2018- 2021. The data was analysed using trend analysis to explain the frequency of the title occurrence and average length of the text. The researchers sought permission from the college librarian in the Department Library through the Institutional Research Review office to have access to projects submitted over the time frame which had been submitted to the Department. The researchers then went to the library on two occasions. The dissertations for the year 2020 were not available due to the pandemic of the Covid19. The analysis of the study was done in tandem with the research questions. We first examined the text length of the project titles. This was done by considering the number of word constituents the titles. In addition, the researchers analyzed the trend used based on grouping the titles into years over a decade, 2007 – 2017, again 2018 – 2021. These were present in tables and graphs.

Results

Table 1: Descriptive Statistics of Undergraduate Student Project Work Titles

	Algebra-related topics			Geometry-related topics		
Years	**Number of Titles**	**Total Number of Words**	**Average length**	**Number of Titles**	**Total Number of Words**	**Average Length**
2007	50	906	18.12	47	938	19.96
2008	46	819	17.80	53	1,060	20.00
2009	50	946	18.92	23	524	22.78
2010	50	1,014	20.28	48	1,032	21.50
2011	22	434	19.73	22	482	21.91
2012	14	218	15.57	23	624	27.13
2013	18	375	20.83	27	618	22.89
2014	20	429	21.45	17	389	22.88
2015	20	419	20.95	11	270	24.55
2016	19	415	21.84	19	464	24.42
2017	20	429	21.45	17	404	23.76
2018	16	355	22.19	23	493	21.43
2019	20	424	21.20	17	364	21.41
2021	50	1123	22.46	72	1,445	20.07

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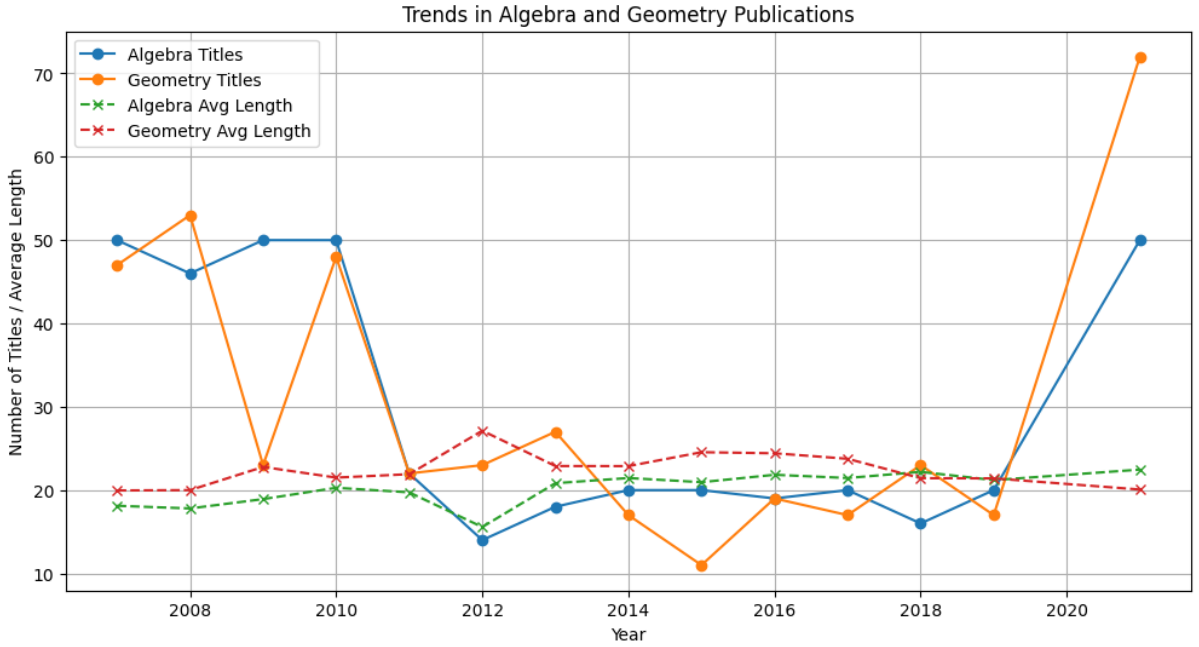

Figure 1: Line graph showing the trends in Project Work titles from 2007 to 2021

The result in Table 1 and Figure 1 explains the trends in titles and word lengths related to Algebra and Geometry topics between 2007 and 2021. These trends were analyzed in terms of the number of titles published, total word count, and average length of the titles each year. The number of Algebra-related titles varied between 14 and 50 per year. From 2007 to 2010, there was a consistently high output, with 50 titles in 2007, 2009, and 2010, while the lowest number of titles occurred in 2012 (14). The total word count ranged from 218 in 2012 to 1,123 in 2021, indicating variability in publication focus. Average title lengths for Algebra topics increased over the years, with the shortest average length in 2012 (M = 15.57) and the longest in 2021 (M = 22.46). This trend suggests a gradual shift towards more descriptive or detailed titles over time. Geometry-related topics exhibited similar fluctuations in the number of titles, ranging from 11 in 2015 to 72 in 2021. Like Algebra, the highest output of titles for Geometry occurred in 2021, reflecting an increased focus on the subject in that year. The total word counts varied, peaking at 1,445 in 2021, while the lowest was recorded in 2015 (270). Title lengths for Geometry topics also displayed variability, with the shortest average in 2008 (M = 20.00) and the longest in 2012 (M = 27.13). These findings suggest more elaborate titles were prevalent in years with fewer publications. From 2007 to 2017, both Algebra and Geometry-related topics showed relatively stable patterns in publication numbers, but Algebra tended to have a higher number of titles annually. However, Geometry had longer average title lengths in most years. Between 2018 and 2021, there was a notable surge in publications, particularly in 2021, where both topics experienced their peak outputs (Algebra: 50 titles, Geometry: 72 titles). Interestingly, while Algebra titles demonstrated a steady increase in average length over time, Geometry title lengths varied more significantly but remained relatively longer on average in earlier years. Algebra titles show less variation (SD = 15.28) compared to geometry titles (SD = 17.79). The maximum geometry titles in a year (72) exceeds the maximum for algebra titles (50). Average Length: Geometry titles tend to be longer on average (mean = 22.48) than algebra titles (mean = 20.20). Variation in title length (SD) is slightly higher for geometry topics.

Figure 2 presents a bar graph indicating that from 2007-2017, both Algebra (329 titles) and Geometry (307 titles) had significantly more research output compared to 2018-2021 (86 and 112 titles) respectively. This suggests a notable decline in research activity in both areas after a decade.

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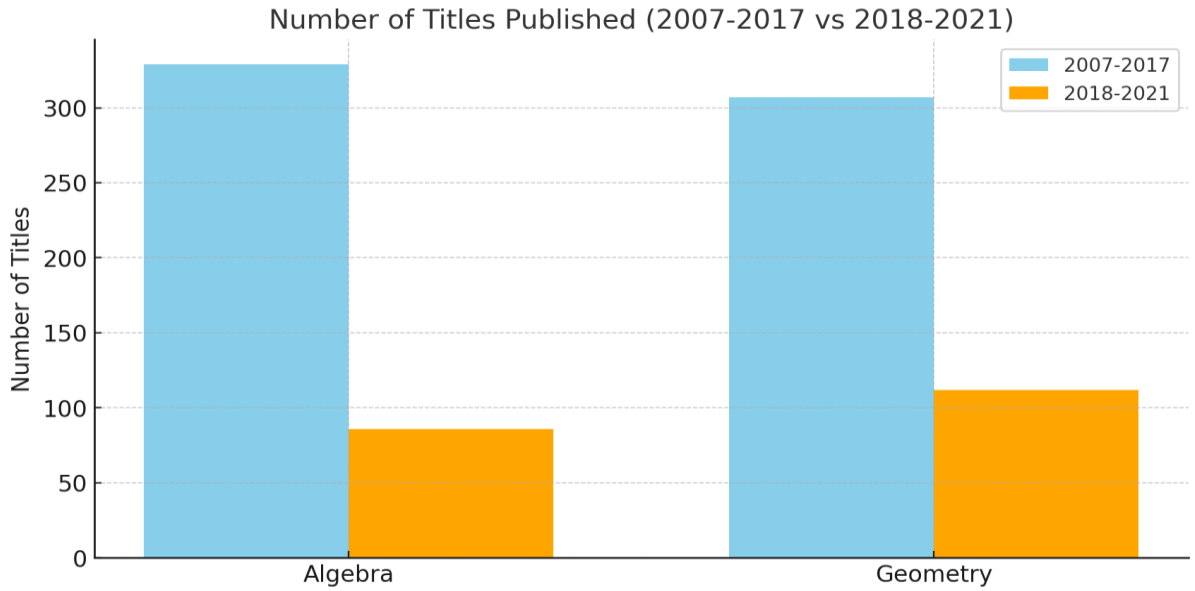

Figure 2: Bar chart comparing 2007 – 2017 and 2018 – 2021

Figure 3 showed the bar chart by stating that, the average title length in Algebra increased from 19.47 words (2007-2017) to 22.12 words (2018-2021) whereas in Geometry, the trend is mixed, with the average title length slightly decreasing from 22.17 words (2007-2017) to 20.55 words (2018-2021). The decline in the number of titles could indicate reduced research focus or shifts in priorities for Algebra and Geometry. Longer average titles after a decade for Algebra suggest growing practices in title construction, potentially reflecting more descriptive or specific research focuses.

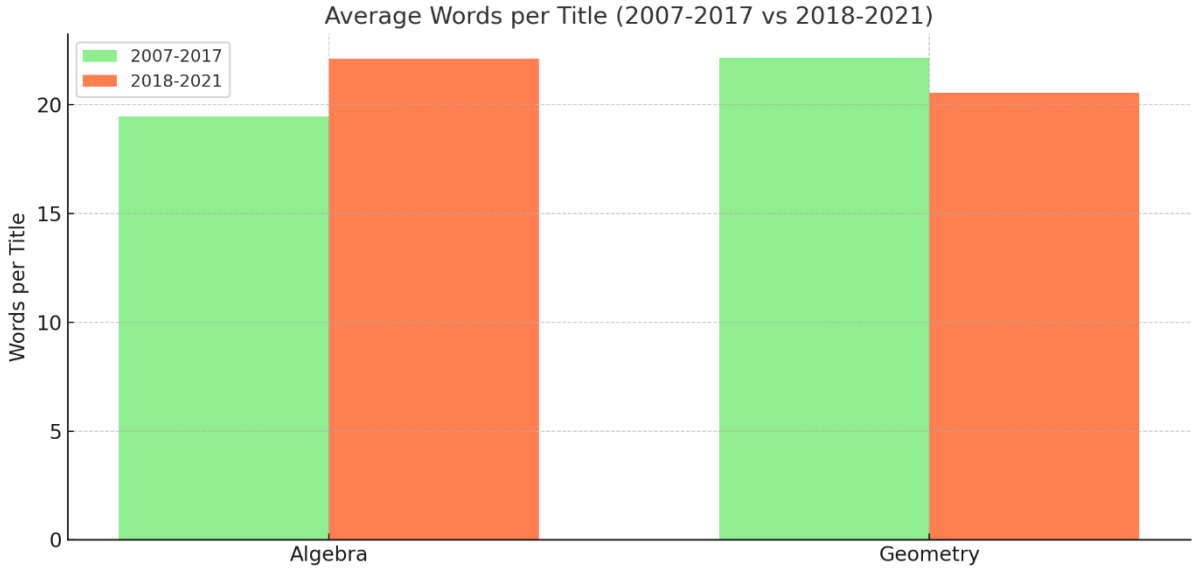

Figure 3: Bar chart comparing Average titles of 2007 – 2017 and 2018 – 2021

Discussion

The trends observed in Algebra and Geometry undergraduate project titles reflect broader patterns of scholarly communication and disciplinary focus over time. These findings align with literature emphasizing the influence of academic conventions, personal choices, and community practices on title characteristics (Thomas 2021; Duff, 2010). The increasing average length of Algebra titles suggests a shift towards more descriptive and detailed phrasing, potentially influenced by informativity and economy, as discussed by Duff (2010). Similarly, the longer and more variable Geometry titles may reflect efforts to capture broader or more nuanced aspects of research topics, consistent with findings by Edwards and Ward (2004) on the increasing complexity of titles over time.

The decline in research activity post-2017 might indicate changing priorities in Mathematics Education or shifts

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in student research interests and institutional emphases. This echoes Akoto's (2018) observation that disciplinary conventions and trends influence the nature and volume of academic output. Geometry titles, being generally longer and more variable, could suggest a trend toward elaboration in topics that require more explanation or contextual framing. This resonates with (Bérubé et al., 2018; Buxton & Meadows, 1977) findings on how disciplinary specificity shapes title structures and lengths. Algebra's steady increase in average title length reflects a more uniform evolution, possibly due to standardized approaches in project focus.

The peaks in title output for both topics in 2021, combined with the decline from 2018-2020, may indicate temporary surges in interest or external influences such as curriculum changes. The findings highlight the need to explore underlying causes, such as policy shifts, supervisor influence, or resource availability, which may have affected research activity. These results provide a diachronic perspective on trends in undergraduate project titles, contributing to a deeper understanding of how topics and title characteristics evolve within Mathematics Education.

The comparison of title lengths and research focus between Algebra and Geometry reveals distinct trends in academic practices. From 2007–2021, Algebra demonstrated a steady increase in average title length, growing from 19.47 to 22.12 words, suggesting a shift toward more descriptive and specific titles that reflect evolving research complexities, as supported by Appiah (2021), who emphasized the role of informativity in academic titles. In contrast, Geometry exhibited a slight decline in average title length, from 22.17 to 20.55 words, indicating a potential preference for conciseness in later years, possibly to enhance accessibility (Thomas, 2021). Furthermore, while both subjects experienced a decline in publication numbers after 2017, the consistent growth in Algebra title lengths may suggest a continued effort to elaborate research topics despite fewer studies, contrasting with Geometry's more variable approach. These differences highlight disciplinary nuances and evolving norms in undergraduate research output and presentation.

Irrespective of the congenial conditions the researchers had, some difficulties were faced during the collection of data. First, the Department had no electronic repository for project works submitted by students for the expected period. Due to this, the researcher had to manually obtain the data. Aside from this, the hard copies of the project works were not arranged into their respective years of submission. Thus, the researchers had to rearrange them before collection and also avoid duplication. Despite this, there were a few duplications which were later dealt with. All these problems made the collection of data tiring and involving. However, were solicited additional hands to overcome these limitations and hence did not influence the study.

Conclusion

The findings of the study reveal that despite institutional transformations in program offerings and course content to align with global practices, there has been no significant descriptive difference in the construction of student project titles from 2007 – 2017 compared 2018 – 2021. This suggests that over a decade of student project work, title construction practices have remained largely unchanged, indicating a gap between institutional advancements and their reflection in student output.

Recommendations

It is therefore recommended that;

1. Institutions should integrate specific training modules on academic writing and research project development into their curriculum. This will equip students with the skills to craft project titles that better reflect evolving program and course content.
2. Organize workshops and professional development programs for faculty members to emphasize the importance of guiding students in constructing project titles that are both descriptive and aligned with contemporary academic and industry standards.
3. Establish a system where student project proposals, including titles, undergo periodic reviews by a committee to ensure they meet the institution's academic and global benchmarks. Feedback mechanisms should be strengthened to encourage improvements in subsequent projects.

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