

Influence of self-financing on the participation of students in Science, Technology, Engineering, and Mathematics [STEM] doctoral programmes in selected universities in Kenya

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ABSTRACT

Doctoral education in Science, Technology, Engineering, and Mathematics (STEM) plays a critical role in developing the highly skilled researchers required to drive innovation and national development in knowledge-based economies. However, participation in doctoral programmes is strongly influenced by the availability and structure of funding mechanisms. In Kenya, limited institutional funding has led many doctoral students to rely on personal financial resources to support their studies. Despite the growing reliance on self-financing, limited empirical evidence exists on how this funding model influences participation in STEM doctoral programmes. This study examined the influence of self-financing on student participation in STEM doctoral programmes in three selected Kenyan universities. Human Capital Theory and Resource Dependence Theory anchored this research. The study adopted a pragmatic paradigm and employed a convergent parallel mixed-methods design. Quantitative data were collected from 210 STEM doctoral students using questionnaires, while qualitative data were obtained through semi-structured interviews with nine departmental heads and focus group discussions with 21 doctoral students. The findings revealed that 64.39% of respondents relied on at least one form of self-financing, including personal savings, loans, and financial support from relatives or friends. Statistical analysis showed no significant difference in participation between self-financing and non-self-financing students ($t = 1.79$, $p = .075$). However, female students were significantly more likely to rely on loans than male students. Qualitative findings revealed that self-financing imposed significant financial pressure on students, creating barriers to enrolment, delaying research progress, and affecting retention in doctoral programmes. The study concludes that while self-financing expands access to doctoral education, heavy reliance on personal financial resources creates structural vulnerabilities that may undermine sustained participation in STEM doctoral programmes. The study recommends expanding structured institutional funding, introducing flexible fee arrangements and targeted research support, and strengthening financial advisory and psychosocial support for self-financed doctoral students.

Keywords: Doctoral Funding, Higher Education Financing, Kenya, STEM Doctoral Education, Self-Financing, Student Participation

I. INTRODUCTION

In the contemporary global economy, knowledge production, scientific research, and technological innovation have become central drivers of national competitiveness and sustainable development. Countries across the world are increasingly investing in higher education systems that can produce highly skilled researchers capable of advancing innovation and addressing complex socio-economic challenges. Doctoral education, particularly in Science, Technology, Engineering, and Mathematics (STEM), plays a critical role in this process because it develops advanced research capacity and contributes to the generation of new knowledge and technologies (Organization for Economic Co-operation and Development, 2018; National Science Board, 2022). STEM doctoral graduates form a key component of the scientific workforce that supports technological advancement, industrial development, and evidence-based policymaking. Consequently, many countries have prioritized strengthening doctoral education systems as part of broader strategies to build knowledge-based economies and remain competitive in the Fourth Industrial Revolution (United Nations, 2024; Trautman, 2023).

Globally, the demand for STEM expertise has continued to grow as economies become increasingly technology-driven. Research and development activities depend heavily on a steady pipeline of doctoral-level researchers who possess advanced analytical and scientific skills (National Center for Science and Engineering Statistics, 2021). Several countries have therefore expanded doctoral education and invested in funding mechanisms to support graduate students, recognizing that financial support plays a crucial role in sustaining research productivity and doctoral completion (Blume-Kohout & Adhikari, 2019; Graddy-Reed et al., 2021). Evidence from higher education research suggests that funding structures influence doctoral students' academic engagement, research productivity, and overall progression within doctoral programmes (Grote et al., 2021). Adequate financial support allows students to devote more time to research activities, whereas financial constraints may force students to seek employment outside their studies, potentially slowing their academic progress.

Within the African context, strengthening STEM education has become a key priority for advancing innovation and economic development. Continental policy frameworks such as the African Union's Agenda 2063 emphasize expanding scientific research and doctoral training to build technological capacity across the continent (African Union, 2024). However, many African universities continue to face structural challenges, including limited research funding and inadequate doctoral support systems (Cloete et al., 2022; Craig et al., 2023).

In Kenya, higher education plays a central role in national development strategies aimed at fostering innovation and industrial transformation. National policy frameworks such as Kenya Vision 2030 emphasize the importance of strengthening science, technology, and innovation as drivers of economic growth and global competitiveness (Republic of Kenya, 2007). STEM education has therefore become a key focus in efforts to build a skilled workforce capable of supporting technological advancement and economic diversification (Muriithi & Musili, 2021). However, despite increasing demand for doctoral training, participation in STEM doctoral programmes remains constrained by structural and financial challenges. Limited government and institutional funding opportunities mean that many doctoral students must rely on personal resources to finance their studies (Ngome et al., 2020).

Self-financing has consequently emerged as a common funding pathway for doctoral students in many developing countries. While this approach may enable some students to enroll in doctoral programmes, it often introduces significant financial pressure that can affect academic engagement and progression. Doctoral education requires sustained investment in tuition, research materials, fieldwork, and living expenses, making financial stability a critical factor for successful participation. Students who depend on personal income or family support frequently face competing financial responsibilities, including employment obligations, which may reduce the time available for research and extend the duration of doctoral study (Bekova, 2021; Caparrós-Ruiz, 2019). Financial constraints have also been associated with increased risks of delayed completion and attrition among doctoral students (Council of Graduate Schools, 2020; Wollast et al., 2018).

Despite growing recognition of the importance of doctoral funding, empirical research examining how specific funding models influence student participation in STEM doctoral programmes in Kenya remains limited. Understanding the implications of self-financing is particularly important because reliance on personal resources may create barriers to access for academically qualified individuals who lack sufficient financial means. This situation raises important concerns regarding equity, participation, and the sustainability of doctoral education systems. This study, therefore, examined the influence of self-financing on student participation in STEM doctoral programmes in three selected Kenyan universities, referred to as University Alpha, University Beta, and University Sigma to maintain institutional anonymity. Although previous studies have examined challenges affecting doctoral education in Africa, limited empirical research has specifically explored how reliance on self-financing influences students' participation, progression, and experiences in STEM doctoral programmes within the Kenyan context. This study addresses this gap by examining how self-financing shapes doctoral students' participation and experiences. The findings provide empirical evidence that can inform institutional and national policies aimed at strengthening funding structures and improving participation in STEM doctoral education in Kenya.

1.1 Statement of the Problem

Doctoral education in Science, Technology, Engineering, and Mathematics (STEM) plays a critical role in strengthening research capacity and supporting innovation-driven economic development. Countries seeking to build competitive knowledge-based economies rely on doctoral graduates to generate new knowledge, advance scientific research, and contribute to technological progress (National Science Board, 2022; Organization for Economic Co-operation and Development, 2018). As a result, universities worldwide have expanded doctoral programmes and invested in mechanisms aimed at supporting postgraduate education and research.

Despite this global emphasis, participation in doctoral programmes remains constrained by several challenges, particularly in developing countries. One of the most significant barriers is the financing of doctoral education. Doctoral training requires substantial financial resources to cover tuition fees, research activities, academic materials, and living expenses. In many African universities, limited institutional and government funding opportunities mean

that a large proportion of doctoral students must rely on personal or family resources to finance their studies (Ngome et al., 2020). Financial pressures associated with self-financing can reduce students' ability to engage in academic work fully, prolong the duration of study, and increase the risk of delayed completion or attrition (Council of Graduate Schools, 2020; Wollast et al., 2018).

In Kenya, the expansion of postgraduate education has increased demand for doctoral training, particularly in STEM fields that are critical to national development priorities outlined in Kenya Vision 2030 (Republic of Kenya, 2007). However, limited structured funding opportunities have led many doctoral students to rely heavily on self-financing. While self-financing may enable access to doctoral education, it may also create financial constraints that affect participation and progression in doctoral programmes. Despite the growing importance of doctoral education, limited empirical evidence exists on how self-financing influences participation in STEM doctoral programmes in Kenyan universities. This study, therefore, examined the influence of self-financing on student participation in STEM doctoral programmes in three selected Kenyan universities.

1.2 Research Objective

To establish the influence of self-financing on the participation of students in STEM doctoral programmes in selected universities in Kenya.

II. LITERATURE REVIEW

2.1 Theoretical Review

The relationship between doctoral education and national development can be understood through several theoretical perspectives that explain the value of higher education and the role of resources in shaping educational participation. Among the most relevant frameworks for examining doctoral education funding are Human Capital Theory and Resource Dependence Theory.

Human Capital Theory, originally advanced by Gary Becker, argues that investment in education enhances the knowledge, skills, and competencies of individuals, thereby increasing productivity and contributing to economic growth (Becker, 1964). From this perspective, doctoral education represents a high-level investment in human capital because it equips individuals with advanced research skills, specialized knowledge, and the capacity to generate innovations. Governments and institutions, therefore, invest in doctoral education in order to strengthen national research systems and promote technological development. STEM doctoral graduates are particularly important because they contribute directly to scientific discovery, technological advancement, and the development of solutions to complex societal challenges. Studies on human capital emphasize that sustained investment in advanced education is necessary for countries seeking to build competitive knowledge-based economies (Winterton & Cafferkey, 2019; Moodie & Wheelahan, 2023). Within the context of doctoral education, Human Capital Theory suggests that adequate financial support is essential for enabling students to complete advanced training successfully. Doctoral programmes require significant time and intellectual commitment, and students must often devote several years to intensive research activities. When students have access to stable funding, they are better able to concentrate on academic work and research productivity. Conversely, financial constraints may limit students' ability to engage in their studies fully and can delay completion of doctoral programmes. Critics of Human Capital Theory, however, argue that the theory sometimes overlooks structural inequalities that affect access to education, including disparities in financial resources and institutional support (Marginson, 2019; Choudhury & Choudhury, 2022).

Another theoretical framework relevant to this study is Resource Dependence Theory, developed by Jeffrey Pfeffer and Gerald R. Salancik. This theory explains how organizations depend on external resources to sustain their operations and achieve their objectives (Pfeffer & Salancik, 1978). According to this perspective, universities depend on external sources of funding such as government allocations, research grants, scholarships, and fellowships in order to support academic programmes and research activities. When such resources are limited, institutions may struggle to provide adequate support for doctoral students. Resource Dependence Theory also highlights the ways in which resource availability shapes organizational behavior and outcomes (Hillman et al., 2009; Davis & Cobb, 2010). In the context of doctoral education, funding availability influences the types of support universities can offer to doctoral students, including scholarships, assistantships, and research grants. When institutional funding is limited, students may be required to rely on personal financial resources to sustain their studies. This dependence on self-financing can create financial pressures that affect students' academic engagement, research productivity, and persistence within doctoral programmes.

Together, Human Capital Theory and Resource Dependence Theory provide a useful framework for understanding the relationship between funding mechanisms and participation in doctoral education. While Human Capital Theory emphasizes the importance of investing in advanced education to build national research capacity, Resource Dependence Theory highlights how institutional resource constraints influence the availability of financial

support for doctoral students. These theoretical perspectives, therefore, provide a foundation for examining how self-financing affects participation in STEM doctoral programmes. These theoretical perspectives guide the interpretation of the present study. Human Capital Theory provides a foundation for understanding why doctoral education represents an important investment in advanced skills and national development. At the same time, Resource Dependence Theory helps explain how limitations in institutional funding structures shape the financial experiences of doctoral students and contribute to reliance on self-financing. Together, these frameworks inform the study's examination of how financial resource constraints influence participation in STEM doctoral programmes in Kenyan universities.

2.2 Empirical Review

Empirical research on doctoral education consistently shows that funding arrangements play a critical role in shaping students' participation, progression, and completion outcomes. Existing studies highlight several key issues related to doctoral funding, including the influence of funding mechanisms on academic outcomes, the effects of employment during doctoral study, gender-related differences in financing patterns, and the broader challenges affecting doctoral education in African contexts.

2.2.1 Funding Mechanisms and Doctoral Outcomes

A substantial body of research demonstrates that the structure and stability of funding mechanisms significantly influence doctoral students' academic engagement and research productivity. Students who receive structured financial support through scholarships, fellowships, or assistantships demonstrate stronger research engagement and are more likely to progress efficiently through their doctoral programmes. For example, Blume-Kohout and Adhikari (2019) found that doctoral students with stable funding arrangements were better able to dedicate time to research activities, which positively influenced their research productivity and skill development. Similarly, Grote et al. (2021) observed that funding mechanisms affect not only students' ability to remain enrolled but also the quality of their research engagement and professional development during doctoral training.

2.2.2 Employment During Doctoral Study

In situations where structured funding is limited, many doctoral students rely on employment or personal financial resources to support their studies. While employment can provide necessary financial support, extensive work commitments may negatively affect doctoral progress. Bekova (2021) found that doctoral students who engage in significant external employment during their studies often experience delays in completing their degrees because work responsibilities compete with research demands. Additional studies on doctoral completion patterns also indicate that financial stress and employment pressures can contribute to delayed completion or even attrition among doctoral students (Council of Graduate Schools, 2020; Wollast et al., 2018). These findings highlight the importance of stable financial support in enabling students to focus fully on research activities.

2.2.3 Gender and Doctoral Funding

Research also suggests that funding patterns and financial experiences in doctoral education may vary across demographic groups, including gender. Some studies have found that female doctoral students may face greater financial constraints due to structural inequalities in income, employment opportunities, and access to financial resources. These disparities can influence the strategies students use to finance their studies, including the use of loans, personal savings, or family support. Understanding these differences is important because financial pressures may affect participation and progression differently across student groups.

2.2.4 Doctoral Education in African Contexts

Within African higher education systems, funding challenges represent one of the most significant constraints affecting doctoral education. Many universities across Sub-Saharan Africa operate within limited financial environments that restrict their ability to provide scholarships, assistantships, or research grants for doctoral students (Cloete et al., 2022). As a result, doctoral candidates often rely heavily on personal or family resources to finance their studies. This reliance on self-financing can place considerable financial pressure on students, particularly in STEM disciplines where research activities require significant financial investment.

Studies focusing specifically on doctoral education in Kenya highlight similar challenges. Ngome et al. (2020) note that many doctoral students in Kenyan universities depend on self-financing due to limited scholarship opportunities and inadequate research funding. While self-financing may enable access to doctoral education for some students, it can also create barriers for academically qualified individuals who lack sufficient financial resources. Overall, the empirical literature suggests that funding structures play a critical role in shaping participation and success in doctoral education. However, despite growing interest in doctoral education in Africa, limited empirical

research has specifically examined how self-financing influences participation in STEM doctoral programmes in Kenyan universities. This study, therefore, addresses an important gap by examining how reliance on self-financing shapes doctoral participation within the Kenyan context.

III. METHODOLOGY

3.1 Research Design

This study adopted a pragmatic research paradigm and employed a convergent parallel mixed-methods design to examine the influence of self-financing on student participation in STEM doctoral programmes. The pragmatic paradigm was considered appropriate because it allows the integration of both quantitative and qualitative approaches in order to provide a comprehensive understanding of complex research problems (Creswell & Creswell, 2023). In this study, the mixed-methods approach enabled the researcher to combine statistical analysis of survey data with qualitative insights from interviews and focus group discussions. The convergent parallel design allowed quantitative and qualitative data to be collected concurrently, analyzed separately, and then integrated during interpretation to provide a more complete understanding of the influence of self-financing on doctoral participation (Creswell & Clark, 2018).

3.2 Study Area and Target Population

The study was conducted in three selected Kenyan universities offering STEM doctoral programmes. To maintain institutional confidentiality, the universities are referred to as University Alpha, University Beta, and University Sigma. These universities were selected because they offer established doctoral programmes in STEM disciplines and enroll a significant number of doctoral students. The three universities were selected purposively based on their established doctoral programmes in STEM disciplines, their enrollment of a significant number of doctoral students, and their representation of both public and private university contexts within Kenya. These institutions were therefore considered suitable sites for examining doctoral funding experiences and participation patterns. The target population consisted of all STEM doctoral students enrolled in the selected universities, as well as departmental heads responsible for managing doctoral programmes. Doctoral students were considered the primary respondents because they directly experience the financial challenges associated with doctoral education. Departmental heads were included to provide institutional perspectives regarding doctoral funding and student participation.

3.3 Sample Size and Sampling Techniques

The sample size of 210 doctoral students was considered adequate to provide a reliable statistical analysis and representation of the doctoral student population within the selected universities. In addition, nine departmental heads were purposively selected to participate in semi-structured interviews because of their roles in overseeing doctoral programmes and student progress. For the qualitative component, three focus group discussions were conducted involving a total of 21 doctoral students. Participants for the focus group discussions were selected purposively to capture diverse experiences related to doctoral funding and participation.

3.4 Data Collection Instruments

Data were collected using structured questionnaires, semi-structured interview guides, and focus group discussion guides. The questionnaire was used to gather quantitative data from doctoral students regarding their sources of funding, financial experiences, and participation in doctoral programmes. Semi-structured interviews with departmental heads provided deeper insights into institutional perspectives on doctoral funding and student participation. Focus group discussions with doctoral students enabled the researcher to capture shared experiences and perceptions regarding the challenges associated with self-financing doctoral education. The research instruments were developed based on existing literature on doctoral education financing and student participation. Prior to the main data collection, the questionnaire and interview guides were pilot-tested with a small group of doctoral students to ensure clarity and relevance of the questions. Feedback from the pilot study was used to refine the wording and structure of the instruments.

3.5 Data Analysis

Quantitative data collected through questionnaires were analyzed using descriptive and inferential statistical techniques. Descriptive statistics were used to summarize the characteristics of respondents and funding patterns among doctoral students. Inferential statistics, including chi-square tests and independent-samples t-tests, were used to examine the relationship between funding models and student participation. Qualitative data obtained from interviews and focus group discussions were analyzed using thematic analysis, which involved identifying recurring themes and patterns related to students' experiences with self-financing and participation in doctoral programmes. The integration

of quantitative and qualitative findings enabled a comprehensive interpretation of how self-financing influences participation in STEM doctoral education. The thematic analysis followed several stages, including familiarization with the data, initial coding, identification of recurring patterns, and development of broader themes. Transcripts from interviews and focus group discussions were carefully reviewed to identify meaningful units of analysis, which were then grouped into thematic categories reflecting participants' experiences with self-financing. To enhance the trustworthiness of the analysis, emerging themes were reviewed and refined through repeated comparison with the raw data.

3.6 Ethical Considerations

Ethical approval for this study was obtained from the Institutional Review Board of Masinde Muliro University of Science and Technology, and a research license was secured from the National Commission for Science, Technology, and Innovation (NACOSTI). Permission was also granted by the participating universities, which are referred to using pseudonyms to ensure institutional anonymity. Participation was voluntary, and informed consent was obtained from all respondents. Confidentiality was maintained by removing identifying information, and all research data were securely stored and used solely for academic purposes.

IV. FINDINGS & DISCUSSION

4.1 Descriptive Statistics on Self-Financing

To establish the financial landscape of STEM doctoral students in the study, respondents were asked to indicate whether they had utilized various forms of self-financing to support their education. Self-financing was operationalized through three main categories: personal savings, loans (either formal or informal), and monetary contributions from relatives or friends. This categorization allowed for a multidimensional understanding of how students navigate tuition costs, living expenses, and research-related expenditures in the absence of full institutional support. Table 1 summarizes the number and percentage of respondents who reported utilizing each type of self-financing mechanism.

Table 1

Self-financing Mechanisms among STEM Doctoral Students

Self-financing Mechanism	Frequency	Percentage (%)
Personal Savings	73	34.76
Student or Personal Loans	71	33.81
Donations from Relatives/Friends	112	53.33
Used at Least One Form of Self-financing	135	64.39

The proportion of self-financed doctoral students observed in this study is relatively high compared to many higher education systems where structured scholarship programmes play a larger role in doctoral funding. Similar patterns of heavy reliance on personal or family resources have been documented in several developing country contexts where institutional funding opportunities remain limited. Table 1 shows that out of the 210 respondents, 135 (64.39%) reported that they had relied on at least one form of self-financing, whether through personal savings, loans, or financial support from family and friends. This points to a significant level of private financial responsibility among doctoral students, indicating that self-financing is not marginal but central to the pursuit of STEM education at the doctoral level.

Among the specific mechanisms, financial donations from relatives or friends were the most common, reported by 53.33% of respondents. This reflects the social embeddedness of educational financing, where students often rely on extended kinship networks and community support systems to bridge funding gaps. Such informal support often compensates for institutional deficiencies in scholarship availability or accessibility, a pattern widely observed in developing contexts where formal student loan systems are nascent or insufficient, leading to a heavy reliance on family and community support for educational advancement. This reliance echoes the challenges faced by self-financed students highlighted by Bekova (2021), Wollast et al. (2018), and Caparros-Ruiz (2019), where the need to manage personal finances often detracts from academic focus. Use of personal savings was less frequent, with only 34.76% of students indicating they had funded their education through this method. This relatively low proportion suggests that a majority of students either lack the financial capacity to save meaningfully before entering doctoral study or prioritize other sources of funding. Similarly, loan uptake was reported by 33.81% of participants, highlighting a comparable reliance on credit. The similarity between savings and loan usage suggests that while students may explore both asset-based and debt-based strategies, each is only feasible for a limited segment of the doctoral population.

The cumulative result that over 64% of students had to finance their education through one or more private means highlights a structural reliance on self-funding within the doctoral education ecosystem. It also signals a potential vulnerability, as dependence on personal or informal resources may expose students to financial instability and academic risk. Overall, the findings confirm that self-financing remains a structurally embedded feature of advanced academic pursuits, shaping both the accessibility and progression of doctoral students in the STEM disciplines.

4.2 Self-financing Across Demographic Variables

The findings presented in Table 2 provide an in-depth understanding of how self-financing practices vary across key demographic variables among STEM doctoral students.

The analysis used the Chi-square test of independence to examine associations between categorical variables. This statistical approach was appropriate for the nature of the data, which involved nominal-level independent and dependent variables.

Table 2

Chi-Square Test Results of Self-financing by Demographic Factors

Demographic Variable	Self-financing Method	% Reporting Yes (for each demographic variable)	χ^2 (df)	p-value
Gender				
Male	Personal savings	33.9%	0.097 (1)	.756
Female	Personal savings	36.0%		
Male	Loans	28.1%	4.160 (1)	.041
Female	Loans	41.6%		
Male	Donations	51.2%	0.503(1)	.478
Female	Donations	56.2%		
Age Group				
18-30	Personal savings	40.0%	2.898 (4)	.575
31-35	Personal savings	29.2%		
36-40	Personal savings	27.7%		
41-45	Personal savings	33.3%		
Above 45	Personal Savings	41.2%		
18-30	Loans	35.0%	1.476 (4)	.831
31-35	Loans	33.3%		
36-40	Loans	27.7%		
41-45	Loans	39.2%		
Above 45	Loans	33.8%		
18-30	Donations	50.0%	2.397 (4)	.663
31-35	Donations	58.3%		
36-40	Donations	58.3%		
41-45	Donations	38.6%		
Above 45	Donations	38.6%		
Field of Study				
Pure and Applied Sciences	Personal savings	31.9%	0.587 (3)	.899
Technology	Personal savings	34.6%		
Engineering	Personal savings	33.3%		
Mathematics	Personal savings	29.8%		
Pure and Applied Sciences	Loans	29.8%	1.919 (3)	.589
Technology	Loans	34.6%		
Engineering	Loans	40.7%		
Mathematics	Loans	50.9%		
Pure and Applied Sciences	Donations	51.1%	0.635 (3)	.888
Technology	Donations	57.7%		
Engineering	Donations	53.7%		
Mathematics	Donations	35.4%		
Academic Year				
Year 1	Personal savings	34.9%	0.034 (2)	.983
Year 2	Personal savings	33.9%		
Year 3	Personal savings	38.5%		
Year 1	Loans	28.9%	1.595 (2)	.451

Year 2	Loans	35.5%		
Year 3	Loans	50.8%		
Year 1	Donations	55.4%	0.317 (2)	.853
Year 2	Donations	53.2%		
Year 3	Donations	34.9%		

Table 2 shows that among male students, 33.9% reported using personal savings, compared to 36.0% of female students. The difference was not statistically significant, $\chi^2 (1) = 0.10$, $p = .756$. This suggests that male and female students were similarly likely to rely on personal savings to support their doctoral education. For loans, 28.1% of male students and 41.6% of female students reported using this financing method. The chi-square test indicated a significant association between gender and loan use, $\chi^2 (1) = 4.16$, $p = .041$. This result implies that female students were more likely than male students to rely on loans as a means of financing their studies. When it came to donations, 51.2% of male and 56.2% of female students reported receiving donations. However, the association between gender and donations was not statistically significant, $\chi^2 (1) = 0.50$, $p = .478$. Therefore, gender did not influence students' likelihood of receiving donation-based financial support.

Students aged 18–30 reported the highest reliance on personal savings at 40.0%, while those aged 36–40 had the lowest at 27.7%. Despite this variation, the association between age group and personal savings was not statistically significant, $\chi^2 (4) = 2.90$, $p = .575$. This suggests that personal savings usage is not dependent on age group among the students sampled. Loan use ranged from 27.7% in the 36–40 age group to 39.2% in the 41–45 age group. However, the chi-square test showed no significant association between age and loan use, $\chi^2 (4) = 1.48$, $p = .831$. For donations, the highest usage was observed in both the 31–35 and 36–40 age groups at 58.3%, while the lowest was in the 41–45 and above 45 categories, both at 38.6%. Nonetheless, the test revealed no significant difference, $\chi^2 (4) = 2.40$, $p = .663$. Overall, age was not a significant factor influencing the choice of self-financing method.

Among students in different fields, the use of personal savings was highest in technology (34.6%) and lowest in Mathematics (29.8%). However, the relationship between field of study and personal savings was not statistically significant, $\chi^2 (3) = 0.59$, $p = .899$.

Loan use ranged from 29.8% in both Pure and Applied Sciences and Technology to 50.9% in Mathematics, which was the highest. Despite this variation, the chi-square test indicated no significant association, $\chi^2 (3) = 1.92$, $p = .589$. Similarly, donations were reported by 35.4% of Mathematics students and up to 57.7% of those in technology, with no significant difference observed, $\chi^2 (3) = 0.64$, $p = .888$. These results show that the academic discipline of a student does not significantly influence the likelihood of using personal savings, loans, or donations for financing their education.

Finally, the academic year did not exhibit a statistically significant relationship with any of the self-financing methods. For personal savings, the test returned $\chi^2 (2) = 0.034$, $p = .983$, with usage rates being nearly identical across Year 1 (34.9%), Year 2 (33.9%), and Year 3 (38.5%). The minimal differences and the very high p-value suggest that progression in the academic programme does not influence reliance on personal savings. Similarly, loan usage did not differ significantly across academic years, $\chi^2 (2) = 1.595$, $p = .451$. The distribution showed that 28.9% of Year 1 students used loans, compared to 35.5% in Year 2 and 50.8% in Year 3. These figures imply that students further along in their programme may be more likely to rely on loans. Donation-based financing also showed no significant relationship with academic year, $\chi^2 (2) = 0.317$, $p = .853$. Reported usage was 55.4% in Year 1, 53.2% in Year 2, and 34.9% in Year 3. The lack of variation reinforces the interpretation that donation support is likely based on stable external sources or informal networks that remain consistent throughout the doctoral journey.

The most notable finding was that female students were significantly more likely than male students to rely on loans. This result implies that female students faced distinct financial needs, aligning with broader literature on gendered financial vulnerabilities and disparities in economic opportunities that may compel women to take on more debt for educational advancement.

This also relates to the concerns about social inclusion raised by Rossello (2023) regarding the impact of funding policies on access for underrepresented groups, suggesting that specific financial planning support may need to be gender-responsive in the context of STEM doctoral programmes. These findings suggest a relatively uniform pattern of self-financing across most groups, with the notable exception of gender-related differences in loan use. Institutions and policymakers should consider the implications of this gender disparity, especially when designing loan programmes or financial counseling services for doctoral students in STEM fields.

4.3 Relationship between Self-financing and Participation in STEM Doctoral Programmes

This section examines the relationship between self-financing and participation in STEM doctoral programmes. The analysis focused on whether there was a significant difference in participation between students who

reported using at least one form of self-financing (personal savings, loans, or donations) and those who did not. The measure of participation was derived from a composite score based on four Likert-scale items assessing student motivation, commitment, progress, and confidence in completing their programmes. Table 3 presents the results of the independent samples t-test conducted to compare the participation levels between the two groups.

Table 3

Independent Samples t-Test Comparing Level of Participation in STEM Doctoral Programmes by Self-Financing Status

Group	N	M	SD	t	df	p	MD	95% CI for MD
Did not self-finance	50	4.65	0.38					
Used at least one form of self-financing	160	4.53	0.411	1.79	208	.075	0.12	[-0.012, 0.246]

Note: M=Mean; SD=Standard deviation; MD=Mean difference. Levene's test for equality of variances: $F(1, 208) = 0.013$, $p = .908$.

The findings from the independent samples t-test showed that students who did not use self-financing had a slightly higher mean participation score ($M = 4.65$, $SD = 0.38$) compared to those who used at least one form of self-financing ($M = 4.53$, $SD = 0.411$). The mean difference of 0.12 was not statistically significant at the 0.05 level, $t(208) = 1.79$, $p = .075$, assuming equal variances. Levene's test confirmed the assumption of equal variances, $F(1, 208) = 0.013$, $p = .908$. The confidence interval for the mean difference (95% CI [-0.012, 0.246]) includes zero, further confirming the non-significance of the difference.

Given that the p-value exceeded the conventional alpha level of 0.05, the null hypothesis (H_{01}), which stated that there is no significant difference in participation in STEM doctoral programmes between self-financing students and those who do not self-finance, was not rejected. This result suggests that, in this sample, self-financing did not lead to statistically discernible differences in how students participated in their doctoral programmes. While there was a marginal trend toward higher engagement among those who did not self-finance, the evidence was not strong enough to confirm a meaningful difference. This outcome suggests a more complex relationship than a direct causal link, echoing other studies that find doctoral students often exhibit high levels of resilience and commitment to their studies, even in the face of financial adversity.

This complexity aligns with observations from Bekova (2021) and Fetene and Tamrat (2021), where, despite significant financial pressures and the necessity of external employment, students often persist, albeit with potential delays in completion. Although the difference in participation between self-financing and non-self-financing students was not statistically significant, the pattern is still analytically important. The direction of the results suggests that students who do not self-finance reported slightly stronger participation, and the p-value indicates that this pattern is close enough to warrant interpretation rather than dismissal. The non-significant result does not mean self-financing is inconsequential. Instead, it suggests that self-financing affects doctoral participation through pathways that are not fully captured by a general participation scale, particularly where students sustain motivation and commitment while experiencing financial disruptions that slow progress and weaken research intensity.

This interpretation is consistent with the logic of Human Capital Theory (Becker, 1964). Self-financing represents a strong private investment in advanced skills, which can strengthen personal commitment and persistence even under strain. In this study, self-financed students maintain participation partly because the doctorate is perceived as a high-return credential worth sacrificing for. However, Resource Dependence Theory (Pfeffer & Salancik, 1978) provides a critical complement by explaining why participation may remain high while progression becomes fragile. When students depend on unstable resources such as intermittent family donations, casual income, or loans, they may remain enrolled and motivated but operate under constrained autonomy. Their doctoral engagement becomes contingent on unpredictable funding flows, which can generate delays, inconsistent supervisor contact, and postponed research activities even when their self-reported commitment remains strong. Therefore, the most defensible conclusion is not that self-financing has "no influence," but that its influence is complex and partially hidden in quantitative comparisons. Self-financing may preserve participation in a narrow sense (motivation and commitment) while undermining participation in its more demanding doctoral form (steady research productivity, timely milestones, and full academic immersion).

4.4 Thematic Analysis for the Influence of Self-financing on Participation in STEM Doctoral Programmes

To deepen the understanding of how self-financing influences participation in STEM doctoral programmes, a thematic analysis was conducted using data collected from key informant interviews with department heads and focus group discussions with doctoral students. The analysis aimed to capture the lived experiences, institutional perspectives, and perceived effects of financing models on doctoral enrolment, retention, and progression. The themes were derived inductively, guided by the research instruments and informed by patterns emerging from the qualitative

narratives. In line with the quantitative findings, which showed limited yet notable differences in participation between self-financed and non-self-financed students, the qualitative themes reflect a nuanced view of how financial burden, access to support, and systemic factors shape participation in doctoral education. Each theme is discussed in detail below, with anonymized, realistic verbatim quotes used to illustrate the experiences and viewpoints of participants.

4.4.1 Financial Pressure

Thematic analysis of the interviews and focus group discussions revealed that financial pressure was a defining and persistent experience for self-financed students in STEM doctoral programmes across Kenyan universities. This theme cuts across various dimensions, including tuition payment struggles, inability to access essential research resources, delayed progression, and constrained personal welfare. While many respondents reported initial enthusiasm for enrolling in the doctoral programme, their optimism was often tempered by the realities of sustaining academic engagement amidst insufficient or unstable funding. This theme emerged consistently in both key informant interviews and student FGDs, and aligns with quantitative findings that indicated no significant statistical advantage in participation levels for self-financing students, despite their numerical prevalence. A recurring sentiment among self-financed students was the heavy and sustained economic burden that accompanied their academic journey. Several students described struggling to maintain consistent payment of tuition fees and university charges, which often led to intermittent enrollment or deferment. One participant, referred to as *Participant A*, noted:

"Paying for school from my own pocket was a big sacrifice. Some semesters I had to sit out because I couldn't raise the fees on time. My supervisor understood, but it delayed my work."(Participant A, 4th March, 2026)

This quotation highlights not only the direct financial impediments but also the secondary academic consequences. Many students reported needing to pause their studies, which resulted in prolonged timelines and emotional exhaustion. Such patterns suggest that while self-financing enabled initial access to doctoral education, it did not guarantee sustained participation or progression. Heads of departments confirmed this trend. One departmental head (*Key Informant 3*) stated:

"We have many students who come in self-financed, especially from industry, but a good number of them either defer or take longer to finish. The pressure is not just tuition; it is the cost of living, research materials, and even travel to conferences."(Key Informant, 4th March, 2026)

This perspective highlights the multifaceted nature of financial strain. Financial pressure for self-financed students extended beyond tuition. It included unmet costs related to data collection, laboratory materials, fieldwork, and participation in academic events, factors critical to doctoral training in STEM fields. The absence of institutional mechanisms to offset these costs disproportionately affects students who lack external scholarships or formal assistantships. Further analysis showed that self-financed students often attempted to supplement their income through part-time work, consultancy, or teaching, which came at a cost to their academic focus and personal well-being. *Participant C*, a third-year doctoral student, shared:

"To survive, I've taken on teaching assignments at a private college. It helps pay the bills, but it also means I don't get enough time to write or meet my supervisor as often as I should."(Participant C, 5th March, 2026)

This dual burden of studying and working undermined the full intellectual immersion typically expected in doctoral education. Students repeatedly indicated that such arrangements, while necessary for survival, compromised the depth and quality of their research engagement. Some even described being mentally and physically exhausted, leading to reduced academic productivity and lower research output. A critical observation from FGDs was that students who self-financed often delayed key milestones in their doctoral journey. These included proposal defense, field data collection, and thesis submission. Several participants cited the inability to afford specialized software, laboratory reagents, or international publication fees as barriers to progression. As *Participant F* explained:

"I had my proposal ready last year, but couldn't proceed with data collection until this year because the equipment I needed wasn't available at the university. Hiring it externally was too expensive for me."(Participant F, 5th March, 2026)

This example illustrates the structural constraints faced by self-financing students within institutional settings that may lack adequate resources. Without supplementary funding, these students are placed in a precarious position that jeopardizes both the timeliness and quality of their doctoral research. Key informants corroborated the view that self-financing students face hidden academic costs. *Key Informant 6*, a professor in a public university, remarked:

"We often assume once a student pays tuition, they are fine. But in STEM, research is expensive. We've had bright students take years just because they couldn't buy basic lab materials. The university has limited funding, and it's even worse for self-sponsored ones." (Key Informant 6, 6th March, 2026)

This statement stresses the inequitable distribution of research support and the compounding disadvantage that self-financed students endure. The observation is particularly troubling in the context of STEM disciplines, which demand considerable financial inputs to support empirical inquiry. Another dimension of financial pressure revealed during analysis was emotional and psychological distress. Many students spoke of anxiety, social isolation, and burnout, all of which they linked directly to financial insecurity. For instance, *Participant G* commented:

"There were times I felt so overwhelmed, especially when everyone else in my cohort seemed to be progressing. I was stuck, not because I lacked ideas, but because I had no money to implement anything." (Participant G, 7th March, 2026)

This quotation illustrates the psychosocial burden borne by self-financed students. Their sense of exclusion and stagnation may compound academic difficulties and increase dropout risk. From a policy standpoint, such stressors point to the urgent need for targeted psychosocial and financial support systems. It is important to note that financial pressure did not affect all self-financed students equally. Some participants, particularly those who held jobs in the private sector or had family support, reported moderate success in managing financial obligations. Nonetheless, they too acknowledged that the absence of structured funding made the doctoral journey unnecessarily arduous. *Participant H*, an industry-sponsored student, said:

"My employer supports part of my tuition, which helps. But everything else is on me, and it's not easy. You still have to plan carefully, and sometimes you just wish there was more institutional help." (Participant H, 7th March, 2026)

This nuanced perspective highlights the importance of distinguishing between types of self-financing. Not all self-funded students are equally disadvantaged; however, all remain vulnerable to academic delays due to the unpredictable nature of personal financial capacity. In summary, this theme strongly demonstrates that financial pressure constitutes a central obstacle to equitable participation and progression in STEM doctoral education among self-financed students. The recurring consequences, delays, absenteeism, low research productivity, and mental distress are indicative of a system that permits access without ensuring sustainability. This theme emerged consistently and aligns with the qualitative findings of Craig et al. (2023) in South Africa, who highlighted how financial constraints, particularly for clinician-researchers funding their own education, significantly limited their ability to engage with academic and research demands fully. Similarly, Bekova (2021) found that off-campus employment, often for self-financing, negatively impacted thesis completion, while Caparros-Ruiz (2019) showed that part-time work delayed PhD completion in Spain.

In the Kenyan context, where extensive external work commitments are often necessary due to self-financing, these findings corroborate that such arrangements, while necessary, compromise the depth and quality of research engagement, as also observed by Fetene and Tamrat (2021), where 'moonlighting' led to prolonged study periods for Ethiopian PhD candidates. To address this, universities must develop more responsive funding mechanisms, especially micro-grants or research bursaries for self-financed students. Additionally, counselling services and mentorship programmes should be more deliberately integrated into doctoral training structures. Without such reforms, self-financed students will continue to shoulder an undue burden, thereby perpetuating inequities in doctoral education outcomes in Kenya's STEM doctoral landscape.

4.4.2 Enrollment Barriers

An important theme that emerged from the qualitative data is the presence of substantial enrollment barriers associated with self-financing. These barriers were multifaceted and extended beyond mere affordability. They included the unpredictability of income sources, lack of access to timely information about funding opportunities, and institutional limitations that failed to support or recognize the unique financial situations of prospective doctoral candidates. Discussions from both the focus group sessions and key informant interviews revealed that many talented individuals are unable to pursue doctoral training in STEM fields, not because of academic unpreparedness, but due to the inability to raise sufficient funds for entry. Several doctoral students shared accounts of having to postpone their enrollment plans by months or even years while they worked to accumulate the required fees. *Participant J*, who was eventually admitted after a three-year delay, explained:

"I knew I wanted to do a PhD in engineering after my master's, but there was no way I could raise the fees immediately. I spent three years saving, applying for scholarships that never came through, and negotiating partial support from my employer." (Participant J, 8th March, 2026)

This testimony highlights the structural rigidity within many academic institutions that operate on a model where financial readiness is a prerequisite for access. Such a model disproportionately affects applicants from underprivileged or underrepresented backgrounds. Notably, respondents consistently identified a lack of bridge funding or enrollment-stage subsidies as a key gap that restricted participation among capable but financially constrained individuals. These findings reflect the structural barriers highlighted by Cloete et al. (2022), who observed that entry into doctoral education in Africa is often inhibited by the lack of transitional or preparatory funding

schemes. The emphasis on financial readiness prior to enrollment creates inequitable access pathways, particularly for students in STEM fields where tuition and research-related costs are often higher. Similarly, Trautman (2023) found that institutions rarely account for socio-economic disparities during the admissions process, effectively excluding academically qualified candidates who cannot demonstrate immediate financial capacity. Departmental heads and programme coordinators corroborated these observations. One key informant, a postgraduate coordinator (Key Informant 2), remarked:

"We receive many inquiries from prospective students who meet all the academic requirements, but once they hear the tuition and related costs, they disappear. They don't apply, or they apply and never register because they can't mobilize the money in time." (Key Informant 2, 10th March, 2026)

This suggests that the enrollment process is not only academically selective but also economically exclusionary. While universities may not intend to discourage self-sponsored applicants, the reality is that most institutions lack accessible financial instruments tailored to early-stage doctoral students, particularly those pursuing STEM research, which often requires significant upfront investment. Another significant barrier cited by participants was the unpredictability and opacity surrounding the availability of funding. *Participant L*, a doctoral candidate in applied mathematics, reflected on her experience:

"I applied without any idea whether scholarships would be available. Information was scattered, and deadlines weren't clear. So I decided to just register and hope I could figure out the finances later. That was a mistake because I struggled to keep up with payments." (Participant L, 10th March, 2026)

This illustrates how the lack of centralized and transparent communication about funding opportunities creates a situation where potential students make poorly informed decisions, often underestimating the actual costs involved. This results in enrollment followed by early academic stress, or in some cases, withdrawal before completing the first academic year. Such patterns reduce the effectiveness of widening access initiatives, as the absence of sustained financial planning renders access superficial. In a similar vein, participants observed that existing funding structures tend to privilege full-time applicants, thereby disadvantaging working professionals or older candidates who often consider self-financing as their only viable route. *Participant M*, a part-time doctoral student, noted:

"Most scholarships are aimed at full-time students below a certain age. At my stage in life, with a family and other responsibilities, I couldn't afford to take time off work or relocate. So I self-financed, but even then, the registration costs were overwhelming." (Participant M, 10th March, 2026)

This narrative brings attention to the intersection of age, employment status, and funding eligibility. Many funding schemes implicitly exclude older, self-financed students even though these individuals often bring valuable professional experience and real-world relevance to doctoral research. The inflexibility of funding criteria, combined with limited installment-based tuition payment options, creates entry barriers for otherwise qualified applicants. From the perspective of faculty administrators, the failure to adequately support self-financed applicants during enrollment stages was seen as a missed opportunity to expand and diversify doctoral education. One interviewee, *Key Informant 7*, shared:

"We are trying to grow our doctoral numbers, but we do not have policies that help students who are willing to pay from their own savings. Even basic things like allowing staggered payment or providing institutional letters that can help them seek external funding. Those things are not standardized." (Key Informant 7, 11th March, 2026)

This highlights an important institutional gap: the absence of a structured support system for guiding self-financing applicants through the enrollment phase. Rather than offering flexible mechanisms that could enable participation, many departments inadvertently reinforce exclusion by adhering to rigid financial procedures. This institutional rigidity aligns with McCowan's (2016) critique of higher education access policies that fail to accommodate non-traditional student needs. He argues that while public universities may formally adopt widening participation frameworks, they often lack the operational flexibility required to support self-financing students, particularly during enrollment. For many prospective students, enrollment decisions are further complicated by their inability to assess the return on investment. The uncertainty about whether the doctorate will lead to tangible professional or economic advancement made some applicants hesitant to commit financially. *Participant N* expressed this concern vividly:

"You're not sure if the PhD will lead to better opportunities. It's a big gamble, especially when you're using your savings or taking a loan. The university doesn't provide much career guidance to show how the doctorate will pay off." (Participant N, 12th March, 2026)

Such perceptions undermine enrollment by fostering a risk-averse attitude among potential students. Without assurances about employability, research opportunities, or career trajectories, the high financial cost of enrolling becomes a disincentive even for capable individuals. Moreover, students from marginalized regions or underfunded universities mentioned that geographic and infrastructural factors compounded their enrollment challenges. Several

respondents indicated that they had to travel long distances to access institutions offering STEM doctoral programmes. This often meant relocating or incurring accommodation costs that were not factored into tuition. As *Participant K* shared:

"There's no institution near me offering a doctorate in my field. I had to move to Nairobi, which meant rent, transport, and living expenses, none of which were covered by any funding. That's before even starting classes." (Participant K 12th March, 2026)

These logistical and financial complications illustrate how the centralization of STEM doctoral training within urban or elite institutions creates regional enrollment disparities. Students outside these hubs face disproportionately higher costs and logistical burdens, thereby reinforcing existing inequalities in higher education access. Breier and Herman (2017) noted that geographic disparities and infrastructural unevenness play a major role in shaping doctoral access across African countries. Students from rural or underserved regions often incur higher participation costs due to travel and relocation expenses, which are seldom covered by institutional grants. In sum, the theme of enrollment barriers brings to light the institutional, financial, and informational limitations that hinder equitable access to STEM doctoral programmes among self-financed students. These obstacles are often invisible in formal policy documents but manifest starkly in the lived experiences of doctoral applicants. While self-financing remains a necessary route for many, the absence of structured support systems during the enrollment phase limits its effectiveness as a sustainable access pathway. This aligns with the limitations discussed in Wollast et al. (2018), where the critical role of funding for persistence was highlighted, but the unique, resource-intensive needs of STEM students were not fully explored.

To mitigate these challenges, several recommendations emerge from the data. Universities should establish clear, accessible, and up-to-date portals listing all available funding options, including timelines and eligibility. Additionally, departments should adopt flexible enrollment procedures that allow for staggered payments, partial deferral of fees, or institutional letters to aid in external fundraising. Most critically, institutions must begin to recognize and respond to the diverse profiles of doctoral students, especially those outside the traditional mold, if they are to truly expand access and build a robust national STEM talent pipeline.

4.4.3 Impact on Retention

One of the most consistent and compelling concerns raised during the interviews and focus group discussions was the effect of self-financing on student retention in STEM doctoral programmes. Across the dataset, participants reported that students who relied on self-funding were significantly more likely to experience prolonged interruptions, deferrals, or even complete withdrawal from their studies. These outcomes were primarily attributed to unsustainable financial burdens, emotional fatigue, and a lack of institutional support mechanisms. The pattern revealed that while students might enter programmes with optimism and motivation, the cumulative effects of financial instability frequently pushed them out of the academic pipeline. This theme reinforces the quantitative findings, which indicated that self-financing was less prevalent among first-year students and more common among those in later stages. This trend may reflect the departure of some students over time due to the inability to sustain the financial demands of doctoral training. Interview data illustrated that retention was not merely a matter of individual perseverance, but rather a function of structural inequalities in funding access and programme design. Many participants emphasized that without systemic intervention, retention challenges would persist. A faculty member, *Key Informant 2*, illustrated the attrition trend with a somber observation:

"We usually admit a good number, but by the third year, the numbers shrink. When we follow up, a large portion of those who leave are the ones who paid their own way. They tell us they just couldn't manage anymore." (Key Informant 2, 13th March, 2026)

This observation points to a systemic vulnerability in the STEM doctoral training model, particularly in environments where institutional support is limited and students must rely heavily on personal or familial resources. The attrition of self-funded students is not random; it is patterned and predictable, indicating a structural problem. These patterns resonate with the findings of Cloete et al. (2015), who demonstrated that attrition in African doctoral education is strongly associated with systemic funding inadequacies rather than academic inability. Students echoed these concerns from a lived-experience perspective. *Participant S*, a doctoral candidate in mathematics, explained the progressive toll that financial strain took on his peers:

"Two of my friends dropped out in the second year. They just couldn't keep up with the fees and still manage to feed their families. One of them told me it felt like he was choosing between his kids and his degree." (Participant S, 13th March, 2026)

This narrative exposes the moral and emotional weight that self-financing students carry. For many, academic aspirations are directly constrained by economic responsibilities beyond the university, including childcare, caregiving, and household support. The burden is often particularly severe for older students or those with dependents. The psychological effects of uncertain funding also contribute to higher attrition. Several participants described how

the constant fear of being deregistered for non-payment made it difficult to stay focused on research or coursework. *Participant G*, studying microbiology, shared:

"I had sleepless nights whenever the semester was ending because I never knew if I'd be allowed to register again. At some point, I stopped attending seminars because I felt I didn't belong anymore." (Participant G, 13th March, 2026)

Such feelings of alienation, shame, and insecurity often precede actual withdrawal from a programme. Even when students technically remain enrolled, the psychological disconnection from the academic community can significantly lower engagement and reduce their chances of completion. This emotional toll aligns with the work of Breier and Herman (2017), who emphasized that financial anxiety among doctoral students can lead to psychological disengagement long before formal withdrawal. They found that persistent uncertainty about tuition payment and research costs produces a sense of academic marginality, which in turn erodes motivation and social integration. Another concerning aspect is that departments generally lack early warning systems or retention strategies specifically for self-financing students. While some institutions have academic advisors or thesis committees, few actively monitor or respond to financial distress among doctoral students. *Key Informant 4*, a supervisor in a chemistry programme, acknowledged this institutional blind spot:

"Our focus is mainly academic, checking research progress, presentations, and coursework. We don't really track students' financial well-being unless they bring it up, which most are reluctant to do. So we often learn too late that someone is struggling." (Key Informant 4, 13th March, 2026)

The lack of proactive outreach or retention programming reflects an implicit assumption that students are responsible for managing their finances independently. This model fails to consider the unique pressures facing doctoral candidates, particularly those in STEM fields where the cost of research is high, and opportunities for flexible employment are limited. Several students described the turning point at which they seriously considered dropping out, often after a long period of academic disengagement. *Participant R*, from an engineering department, explained:

"I had reached a point where I wasn't meeting my supervisor because I hadn't made any progress. I was too stressed about money. I almost deregistered, and it was only after a friend encouraged me that I came back to try one more semester." (Participant R, 13th March, 2026)

The participant's case illustrates how peer networks sometimes serve as informal retention support, offering encouragement when institutional systems fall short. However, such peer-based survival strategies are inconsistent and often insufficient to overcome the larger financial barriers in place. Interestingly, students who did remain enrolled often did so at the cost of lengthened study duration. Rather than dropping out entirely, they would extend their timelines, registering for fewer credits, pausing for semesters, or deferring fieldwork. While this allowed them to stay within the system, it also delayed their professional advancement and contributed to a sense of stagnation. *Participant D*, a doctoral student in agricultural sciences, described his situation:

"I've been here six years now. Not because I'm lazy, but because I had to take a break twice to save up and come back. It's frustrating watching others graduate while you're still stuck." (Participant D, 13th March, 2026)

This prolonged time-to-completion has ripple effects, including higher cumulative costs, delayed entry into academic or research careers, and reduced competitiveness for postdoctoral opportunities. This aligns with findings from Caparros-Ruiz (2019), who found that financial aid accelerated PhD completion times, and implies that self-financing leads to delays in entering research careers. Moreover, Chandler (2018) suggested that while scholarships might not affect PhD completion timelines directly, they do increase the probability of obtaining a tenure-track academic position, further underscoring how financial precarity can disadvantage self-financed students in competitive academic markets. It also reflects inefficiencies in the doctoral pipeline that could be addressed through targeted retention strategies for self-financing students, as also highlighted by Fetene and Tamrat (2021), who focused on financial constraints as a key reason for prolonged study periods among PhD candidates. The inability to offer staggered support, flexible milestones, or customized timelines contributes to protracted study periods that are both financially and psychologically costly, thereby undermining the efficiency of doctoral training programmes and impacting individual career trajectories. Participants across both the student and faculty groups advocated for institutional reforms to support retention. Suggestions included creating financial aid offices that deal specifically with postgraduate students, establishing emergency bursaries for those facing unexpected hardships, and introducing flexible payment plans that align with research timelines rather than fixed semesters. One faculty member, *Key Informant 1*, noted:

"It's time universities started thinking about doctoral retention as a financial issue, not just an academic one. If we lose students, we lose talent and in STEM, that loss is particularly costly." (Key Informant 1, 13th March, 2026)

This reflection captures the broader implications of doctoral attrition: it represents not only individual disappointment but also a systemic failure that undermines national research and innovation goals. Given the cost of

training doctoral students and the strategic role they play in the STEM ecosystem, improving retention among self-financed candidates is both a moral and economic imperative. In sum, the data indicate that self-financing significantly undermines student retention in STEM doctoral programmes. Financial precarity leads to mental distress, disengagement, delayed timelines, and, in many cases, complete withdrawal. These outcomes are not the result of individual weakness but of institutional neglect and an unsustainable funding model. Without targeted interventions, including improved financial support, proactive retention policies, and empathetic advising, many self-funded students will continue to fall through the cracks. Addressing this issue is not only essential for individual student success but also for advancing equitable access to STEM education and ensuring that Kenya builds a diverse and resilient scientific workforce.

4.5 Integrated Interpretation of Quantitative and Qualitative Findings

The integration of quantitative and qualitative findings in this study reveals a layered and multidimensional understanding of the self-financing experience among STEM doctoral students. Quantitative data offered a broad overview of the prevalence and patterns of self-financing. At the same time, qualitative narratives illuminated the lived realities, adaptive behaviour, and emotional dimensions that statistical models alone could not fully capture. Together, these findings highlight the complex relationship between structural constraints and individual agency in the pursuit of doctoral education without institutional financial support, consistent with the foundational principles of Human Capital Theory (Becker, 1964), which highlights individual investment in education, and Resource Dependence Theory (Pfeffer & Salancik, 1978) which points to how individuals navigate resource scarcity within organizational contexts.

Quantitative analysis demonstrated that self-financing is not a peripheral phenomenon but a common and embedded feature of STEM doctoral study, with 64.39% of respondents reporting the use of at least one self-financing mechanism. Donations from relatives or friends were most prevalent (53.33%), followed by personal savings (34.76%) and loans (33.81%). These findings point to the centrality of informal and family-based financial support networks, a pattern widely observed in developing contexts where formal student loan systems are nascent or insufficient, thereby necessitating a heavy reliance on family and community support for educational advancement. Participants frequently described relying on family members for rent, food, or lump-sum tuition contributions. These narratives provided emotional context to the survey figures, revealing the sense of obligation and vulnerability that accompanies informal financial dependence, a challenge often implied in studies discussing the broader financial pressures faced by self-funded students, such as those by Bekova (2021) and Fetene and Tamrat (2021).

The theme of financial pressure, heavily emphasized in both data strands, was highlighted by students' accounts of anxiety, uncertainty, and decisions made under financial duress. This qualitative insight enriches the quantitative finding that self-financing did not statistically hinder participation by showing the intense personal cost involved in maintaining that participation. While the quantitative data did not find statistically significant differences in participation between self-financing and non-self-financing students ($p = .075$), qualitative data revealed how financial strain shaped daily experiences, often leading to mental distress and academic compromises, as documented by Craig et al. (2023) and Caparros-Ruiz (2019) regarding the impact of financial burden and part-time work. Students reported modifying their academic plans, delaying milestones, and navigating feelings of exclusion or shame, underscoring the resilience of individuals who often persist despite significant structural challenges.

Finally, the qualitative theme on coping mechanisms directly enriches the quantitative conclusion that self-financing does not significantly lower participation. Students described strategies such as staggered enrollment, resource-sharing, part-time work, and informal peer mentorship. These coping strategies likely buffer the adverse effects of financial strain, explaining the absence of big statistical differences in participation levels. When integrated, the findings indicate that self-financing does not reliably differentiate students by reported participation, yet it strongly differentiates the quality and security of that participation. Quantitative evidence shows that self-financing is widespread, meaning it is a central funding reality rather than an exception. Qualitative evidence shows that the same funding reality introduces financial stress, delays, and higher withdrawal risk. The apparent stability in participation scores is better interpreted as evidence of student resilience and adaptive persistence, not as evidence that the funding model is benign.

V. CONCLUSION & RECOMMENDATIONS

5.1 Conclusion

This study examined the influence of self-financing on participation in STEM doctoral programmes, focusing on how reliance on personal financial resources shapes students' engagement, persistence, and progression in doctoral education. The findings demonstrate that self-financing is a widespread and structurally embedded feature of doctoral study within the STEM disciplines. Quantitative results revealed that a substantial proportion of respondents relied on

self-financing mechanisms, with 64.39% of the doctoral students reporting the use of at least one form of private financial support. These mechanisms included personal savings, loans, and financial contributions from relatives or friends, highlighting the central role of informal financial networks in supporting doctoral education where institutional funding opportunities are limited.

The statistical analysis further indicated that demographic characteristics such as age, academic discipline, and academic year did not significantly influence the likelihood of using self-financing mechanisms. However, a significant association was observed between gender and loan usage, with female students more likely than male students to rely on loans to finance their doctoral studies. This finding suggests the presence of gender-specific financial challenges that influence how students mobilize financial resources for advanced education. The independent samples t-test examining the relationship between self-financing and participation in doctoral programmes revealed no statistically significant difference between students who self-financed and those who did not. Although non-self-financing students reported slightly higher participation scores, the difference was not statistically significant at the 0.05 level. This suggests that self-financing does not necessarily reduce students' motivation, commitment, or confidence in completing their doctoral programmes.

However, the qualitative findings provided deeper insight into the lived experiences behind these statistical patterns. Interviews and focus group discussions revealed that self-financed students frequently experience financial pressure, delayed academic progression, and emotional stress associated with unstable funding sources. Participants reported difficulties in meeting tuition payments, accessing research resources, and balancing academic responsibilities with income-generating activities. These challenges often resulted in delayed milestones, extended completion timelines, and, in some cases, temporary withdrawal from programmes. Despite these constraints, many self-financed students demonstrated resilience through various coping strategies such as part-time work, peer support networks, and staggered enrollment plans. These strategies allowed students to remain enrolled and maintain participation levels even under difficult financial circumstances. Overall, the findings suggest that self-financing expands access to doctoral education but simultaneously introduces vulnerabilities that may affect the sustainability and quality of participation. Consequently, while self-financing enables entry into doctoral programmes, it may also contribute to delayed completion and increased financial strain for students pursuing STEM research.

This study contributes to both theory and practice in the field of doctoral education financing. From a theoretical perspective, the findings extend Human Capital Theory and Resource Dependence Theory by demonstrating how individual investment in education interacts with institutional funding constraints to shape doctoral participation. While students may remain motivated to pursue doctoral education despite financial pressure, dependence on unstable personal resources creates structural vulnerabilities that affect academic progression and sustainability. From a practical perspective, the study provides empirical evidence that can inform institutional and national policy discussions on doctoral funding in Kenya. The findings highlight the need for more structured financial support systems, particularly in STEM disciplines, to reduce reliance on self-financing and to support the timely progression and completion of doctoral studies.

5.2 Recommendations

Based on the findings of this study, several recommendations are proposed to improve participation and sustainability of STEM doctoral education for students who rely on self-financing. First, universities should expand institutional funding opportunities for doctoral students through structured scholarship schemes, competitive research grants, and graduate assistantship programmes. Establishing dedicated doctoral funding units within graduate schools could help coordinate these opportunities and ensure that students receive consistent financial support throughout their doctoral studies. Increasing access to institutional funding would reduce excessive reliance on personal resources and allow doctoral students to devote more time to research and academic development. Second, universities should introduce more flexible tuition payment structures for doctoral students. For example, institutions could allow staggered fee payments, semester-based installment plans, or research-stage payment models that align tuition schedules with major doctoral milestones such as proposal defense, data collection, and thesis submission. Such flexible arrangements would help self-financed students manage their financial obligations more effectively and reduce interruptions in enrollment caused by rigid payment deadlines.

Third, universities should establish targeted financial advisory services specifically for postgraduate and doctoral students. These services could guide financial planning, budgeting for research activities, identifying available scholarships or research grants, and managing research-related expenses. Dedicated advisory support could also assist students in identifying external funding opportunities from research councils, international donors, and private sector partners. Fourth, universities should develop small research bursaries or micro-grant programmes designed specifically for self-financed doctoral students. These funds could support essential research-related expenses such as laboratory materials, fieldwork costs, specialized software, data collection, and conference participation. Even modest financial support for these activities could significantly improve students' ability to

progress efficiently through key stages of their doctoral research. Fifth, institutional policies should recognize the diverse financial circumstances of doctoral students and incorporate support mechanisms that promote equitable access and retention. Universities could establish emergency funding schemes for students facing unexpected financial difficulties, as well as mentorship programmes that provide academic and psychosocial support for self-financed doctoral candidates. Such initiatives would create a more supportive research environment and reduce the risk of delayed completion or attrition.

Sixth, national policymakers, including the Ministry of Education and the National Research Fund (NRF), should strengthen national doctoral funding programmes that support STEM research. Expanding national scholarship schemes, establishing competitive doctoral research fellowships, and increasing public investment in postgraduate education would reduce the heavy reliance on self-financing and strengthen the national pipeline of highly trained STEM researchers. Finally, future research should further examine the long-term implications of self-financing in doctoral education. Longitudinal studies that track self-financed doctoral students from enrollment to completion could provide deeper insights into how financial pressures influence academic progression, completion timelines, and career outcomes. Comparative studies across different African countries could also provide valuable evidence on how different doctoral funding models shape participation and research productivity in developing higher education systems.

Declaration of Interest

The author declares that she does not have any known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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