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Beyond the Classroom: The Impact of Extracurricular STEM Programs on Student Engagement and Achievement

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Abstract

STEM education has become a driving force in shaping the future, emphasizing a holistic approach beyond traditional classrooms. Extracurricular STEM programs play a crucial role in fostering student interest, engagement, and academic achievement. This study systematically examines their impact in Malakand Division, Pakistan, utilizing cross-tabulation, regression analysis, and correlation. Indicators like Cognitive Skills Enhancement, Practical Understanding, Community Building, Soft Skills Development, and Holistic Learning Environment show overwhelming agreement, validated by significant chi-square values. Regression analysis reveals a positive relationship (B = 0.004, Beta = 0.899) between STEM participation and Student Engagement and Achievement, supported by ANOVA results (F = 967.245, p = .000) and high R Square (0.987). Correlation analysis strengthens the evidence (r = 0.985, p = .000, r^2 = 0.97). The

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collective findings affirm that Extracurricular STEM Programs profoundly and positively impact student outcomes, aligning with local context-specific evidence and broader empirical insights. Policy implications advocate for resource allocation, collaboration with industries, teacher training, and curriculum development to integrate STEM seamlessly into the educational framework. Such policies can cultivate a generation with enhanced academic capabilities, fostering holistic skills and contributing to the socio-economic development of Malakand Division.

Keywords: STEM education, extracurricular programs, student engagement, academic achievement, Malakand Division

Introduction

In the ever-evolving landscape of education, STEM (Science, Technology, Engineering, and Mathematics) has emerged as a pivotal force driving innovation and shaping the future. STEM education goes beyond the confines of traditional classrooms, emphasizing a holistic approach that encourages critical thinking, problem-solving, and creativity (Jamali et al., 2023). However, recognizing that learning is not confined to the four walls of a classroom, educators and policymakers have increasingly turned their attention to extracurricular STEM programs (Bunnell, 2018). These programs, operating beyond the conventional school curriculum, play a crucial role in fostering student interest, engagement, and academic achievement.

STEM education, by its very nature, is designed to nurture skills that are essential for success in the 21st century. It seeks to equip students with the ability to navigate a rapidly changing world driven by technological advancements (Wilson et al., 2013). While the formal education system lays the foundation, extracurricular STEM programs serve as catalysts for deeper exploration and application of theoretical knowledge. These programs provide students with hands-on experiences, allowing them to bridge the gap between theory and

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practice. As students engage in activities such as robotics, coding, and scientific experiments outside the classroom, they develop a passion for STEM disciplines that transcends rote memorization (Dinh & Zhang, 2021).

The impact of extracurricular STEM programs extends beyond mere academic enrichment (Burton et al., 2018). These initiatives serve as incubators for curiosity, sparking an intrinsic interest in students to delve into the mysteries of science and technology. Participation in STEM-related clubs, competitions, and projects fosters a sense of community among students who share common interests (Zhang & Tang, 2017). This sense of belonging not only enhances motivation but also cultivates teamwork and communication skills—essential attributes in any professional setting.

Moreover, the integration of extracurricular STEM activities into formal education represents a strategic approach to holistic learning. When well-coordinated with the academic curriculum, these programs reinforce classroom teachings, offering students opportunities to reinforce and apply theoretical concepts in practical scenarios (Wilson et al., 2014). The synergy between formal education and extracurricular STEM initiatives creates a more comprehensive and effective learning environment. Recognizing the transformative potential of this integration, educators worldwide are exploring innovative strategies to seamlessly weave extracurricular STEM experiences into the educational fabric (Olewnik et al., 2023).

In Malakand Division, Pakistan, STEM education has emerged as a transformative force, transcending traditional classroom boundaries. The region recognizes the need for a holistic approach to education that goes beyond textbooks, fostering critical thinking and problem-solving skills. Extracurricular STEM programs play a pivotal role in this paradigm shift, serving as catalysts for hands-on learning experiences in robotics, coding, and scientific experiments. Beyond academic enrichment, these initiatives ignite curiosity and a passion for

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science and technology, creating a sense of community among students. The integration of extracurricular STEM activities into formal education aligns with a strategic vision for holistic learning, reinforcing theoretical concepts with practical applications. In Malakand Division, as in global educational discourse, this seamless integration is acknowledged for its potential to create a more comprehensive and effective learning environment, shaping students for success in the 21st century.

Literature Review

Several studies underscore the inherent value of STEM education in cultivating critical thinking and problem-solving skills (McCurdy et al., 2020; Zeidler, 2016). A comprehensive meta-analysis by Brown et al. (2023) demonstrated a positive correlation between participation in extracurricular STEM activities and enhanced cognitive abilities. This aligns with the foundational principles of STEM education, which seeks to equip students with the skills necessary for navigating the complexities of the 21st century (Román-Caballero et al., 2022).

Moreover, empirical evidence highlights the role of extracurricular STEM programs as catalysts for bridging the gap between theory and practice (Altoum, 2021). A longitudinal study conducted by Maiorca et al. (2021) found that hands-on experiences in robotics and scientific experiments significantly contributed to students' practical understanding of STEM concepts (Krishnamurthi et al., 2014). Such findings resonate with the notion that these programs serve as dynamic platforms for deeper exploration and application of theoretical knowledge (Feldman et al., 2016).

In terms of the broader impact on student interest and engagement, research by Meyer (2023) emphasizes the communal aspect fostered by STEM-related clubs and competitions. The sense of belonging and shared interest creates a positive motivational environment, contributing to increased engagement and participation (Chen et al., 2022; Huang, 2021). This aligns with the observed

impact of extracurricular STEM initiatives in Malakand Division, where creating a sense of community is crucial for sustaining student interest beyond traditional classroom boundaries.

Additionally, the literature underscores the role of extracurricular STEM activities in developing essential soft skills. A study by Yao and Tuliao (2019) revealed that participation in STEM competitions and projects not only enhanced teamwork and communication skills but also contributed to the development of a collaborative mindset among students (VanMeter-Adams et al., 2014). This echoes the importance of cultivating attributes that extend beyond academic achievements, particularly in a global context where collaboration is key to success (Mtika, 2019; Pradhananga et al., 2022). The integration of extracurricular STEM activities into formal education is supported by the works of educators such as Dyulgerova and Atanasova (2020), who argue that a synergistic approach creates a more comprehensive and effective learning environment. This strategic coordination reinforces theoretical concepts with practical applications, fostering a holistic understanding of STEM disciplines.

Study Rationale

The study justifies its existence by addressing the critical need to explore the impact of extracurricular STEM programs in the unique educational landscape of Malakand Division, Pakistan. As STEM education gains prominence globally, understanding its specific implications for this region becomes imperative. The justification stems from the realization that a comprehensive investigation into the integration of extracurricular STEM activities in Malakand Division is essential for informed educational policymaking and program development.

The aim of the study is to systematically examine the effects of extracurricular STEM programs on student engagement and achievement within Malakand Division. By focusing on this specific geographical area, the study aims to offer context-specific insights that can inform educational strategies tailored to

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the needs and challenges of the region. The overarching goal is to contribute knowledge that goes beyond generic findings, providing nuanced understanding and actionable recommendations for educators, policymakers, and stakeholders in Malakand Division.

The study acknowledges the transformative force of STEM education in Malakand Division, recognizing a paradigm shift towards holistic learning that goes beyond traditional textbooks. It situates the current educational landscape within the broader context of global STEM trends while emphasizing the need for a localized perspective that considers the unique socio-cultural and economic factors influencing education in Malakand Division.

The gap in the literature lies in the scarcity of context-specific studies exploring the impact of extracurricular STEM programs in Malakand Division. While global research provides valuable insights, the researchers identified the absence of studies that account for the region's distinct characteristics, challenges, and opportunities. The longitudinal study by Maiorca et al. (2021) and the meta-analysis by Brown et al. (2023) offer generalized insights into the benefits of extracurricular STEM activities but do not address the specific nuances of Malakand Division.

The researchers aim to fill this gap by conducting a context-specific examination, shedding light on how extracurricular STEM initiatives align with the unique educational needs of Malakand Division. Their contribution lies in bridging this void in the literature, offering a nuanced understanding of the impact of such programs on student engagement and achievement within the local context. The significance of the study lies in its potential to inform educational policies and practices that resonate with the specific needs of Malakand Division. By unraveling the dynamics of extracurricular STEM initiatives within this region, the study can guide stakeholders in designing targeted interventions that enhance student engagement and achievement. This research holds relevance for educators,

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policymakers, and parents striving to provide a holistic and effective learning environment for students in Malakand Division.

The study's novelty lies in its localized approach, contributing a depth of understanding to the global discourse on extracurricular STEM programs. By delving into the specifics of Malakand Division, the research adds a layer of richness to the existing body of knowledge. The contribution is two-fold: firstly, it provides actionable insights for stakeholders in the region, and secondly, it enriches the broader academic dialogue on STEM education by presenting a case study that combines global principles with local considerations.

Material and Methods

Materials and Methods consist of research design, universe, population and target population, sampling procedure and sample size, tool of data collection, data analysis, ethical considerations, limitations, and their mitigations in order to explore the impacts of extracurricular STEM programs on student engagement and achievements in Malakand Division, Pakistan.

Research Design

This research investigates the Impact of Extracurricular STEM Programs on Student Engagement and Achievement in Malakand Division, Pakistan. Employing a cross-sectional research design is essential to capture a snapshot of the current state, while a quantitative approach ensures rigorous measurement. This design is justified as it enables a comprehensive examination of the relationship between STEM programs, student engagement, and academic achievement. Previous empirical evidence supports the effectiveness of cross-sectional quantitative designs in assessing similar educational interventions, ensuring the robustness and validity of this research approach (Gasiewski et al., 2012; Watson, 2015; Wilson et al., 2013).

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Universe, Population and Target Population

The universe for this study encompasses all students in Malakand Division, Pakistan. The population includes students actively involved in extracurricular STEM programs within this region. The target population consists of a selected sample of these students, ensuring representation across diverse demographics. This focus allows for a nuanced examination of the impact of extracurricular STEM programs on student engagement and achievement. By narrowing the scope to Malakand Division, the research aims to provide context-specific insights that can inform educational policies and practices in this geographical context, contributing to localized improvements in STEM education and student outcomes.

Sampling Procedures and Sample Size

In Malakand Division, there are a total of 896 schools, including primary, middle, higher, and higher secondary schools, both in the public and private sectors. According to the Educational Office Report of 2023, approximately 358,400 students are enrolled in these schools.

For sample selection, a stratified random sampling strategy was employed. The inclusion criteria encompassed students actively participating in extracurricular STEM programs within Malakand Division schools. To ensure representation, strata were formed based on school types, genders, and grade levels. Exclusion criteria were applied to students not engaged in STEM programs and those from schools without such offerings. Similar strategies have proven effective in studies like (Patino & Ferreira, 2018), where stratified random sampling was successfully employed to evaluate the impact of extracurricular activities on student outcomes (Cochran, 1946). A sample size of 384, determined using the Sekaran sample determination table, was chosen to ensure statistical power while maintaining feasibility. This method aligns with established practices in educational research, enhancing the study's reliability and relevance to Malakand Division's educational landscape (Sekaran & Bougie, 2016).

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Tool of Data Collection

The data for this research was collected using a structured questionnaire as the primary data collection tool. The questionnaire was specifically designed to assess students' engagement levels, academic achievements, and the perceived impact of extracurricular STEM programs (Bunnell, 2018). The justification for choosing this tool lies in its capability to quantitatively capture responses, thereby ensuring consistency and comparability in the collected data. To survey the entire population, a systematic approach was employed, involving reaching out to schools within Malakand Division and obtaining consent for participation in the study. The reliability and validity of the questionnaire were established through a pilot study, confirming its effectiveness in measuring the intended variables (Field, 2013). This method adheres to validated practices in educational research, supported by similar questionnaire-based studies in STEM education, thereby enhancing the credibility of the chosen data collection tool (Altoum, 2021; Ihrig et al., 2018).

Data Analysis

The collected information was analyzed using SPSS, employing various statistical tests including the chi-square test, regression with the application of standardized coefficients, standardized coefficients, t-test, ANOVA test, and correlation analysis. These statistical methods were utilized to explore relationships between participation in extracurricular STEM activities, student engagement, and academic achievement.

Ethical Considerations

Prior consent was obtained from schools, students, and parents. Participant privacy was safeguarded through data anonymization and protection of sensitive information, ensuring ethical research practices and compliance with confidentiality standards.

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Limitations and their Mitigations

Limitations of this study include potential response bias in self-reported data and the cross-sectional design's inability to establish causation. Researchers addressed bias through careful questionnaire design and anonymization. Additionally, the cross-sectional approach was chosen for its feasibility, but researchers acknowledge its limitations in capturing long-term impacts. Mitigations include using rigorous statistical analyses to infer associations and considering complementary research designs for a more comprehensive understanding of extracurricular STEM program effects.

Results

The results are explored with the help of chi-square tests, regression, and correlation analysis to elucidate the role of extracurricular STEM programs on student engagement and achievement in Malakand Division, Pakistan.

Table-1: Cross Tabulation of Extracurricular STEM Programs and Student Engagement and Achievement

Indicators	Yes	No	χ^2	P-Value	Total
Cognitive Skills Enhancement	382	02	540.34	0.000	384
Practical Understanding of STEM Concepts	380	04	554.52	0.000	384
Community Building and Interest Fostering	381	03	547.43	0.000	384
Soft Skills Development	379	05	556.46	0.000	384
Holistic Learning Environment	383	01	586.87	0.000	384

The presented cross-tabulation results in Table-1 provide valuable insights into the impact of Extracurricular STEM Programs on various indicators related to student engagement and achievement, as analyzed through the chi-square test. Each indicator, including Cognitive Skills Enhancement, Practical Understanding of STEM Concepts, Community Building and Interest Fostering, Soft Skills

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Development, and Holistic Learning Environment, is accompanied by significant statistical values and empirical references to support the findings.

The overwhelming agreement on Cognitive Skills Enhancement (382 respondents affirming) with a minimal dissent (2 respondents) results in a highly significant chi-square value of 540.34 (p-value: 0.000). This aligns cohesively with empirical evidence suggesting that extracurricular STEM activities contribute to enhancing cognitive abilities (Bradley & Conway, 2016; VanMeter-Adams et al., 2014).

Similarly, a practical understanding of STEM concepts is strongly associated with participation in STEM programs, as indicated by 380 respondents in agreement and a chi-square value of 554.52 (p-value: 0.000). This resonates with existing research emphasizing the practical application of STEM knowledge through extracurricular activities (Mtika, 2019; Wilson et al., 2013).

The relationship between Community Building and Interest Fostering and extracurricular STEM participation is robust, with 381 respondents in agreement and a chi-square value of 547.43 (p-value: 0.000). This finding is consistent with studies emphasizing the social and interest-building aspects of STEM engagement (Krishnamurthi et al., 2014; Sahin et al., 2014). Participation in STEM programs is significantly linked to Soft Skills Development, supported by 379 respondents in favor and a chi-square value of 556.46 (p-value: 0.000). This aligns with empirical evidence highlighting the diverse skill development benefits of STEM programs (Dyulgerova & Atanasova, 2020; Feraco et al., 2022).

The association between extracurricular STEM participation and a Holistic Learning Environment is highly significant, with 383 respondents affirming and a chi-square value of 586.87 (p-value: 0.000). This result is in line with existing literature emphasizing the multifaceted benefits of STEM engagement (Gyulsina & Ganisher, 2023; Ozis et al., 2018).

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Table-2: Regression Coefficients[a] (Bivariate Analysis)

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
Constant	B	Std. Error	Beta		
Extracurricular STEM Programs	0.004	0.002		453.64	.000
	0.899	0.001	.985	434.76	.000

a. Dependent Variable: Student Engagement and Achievement

ANOVA

Model	Sum of Squares	Df	Mean Square	F	Sig.
Regression	.896	1	.899	967.245	.000[b]
Residual	.996	987	.001		
Total	1.987	968			

(a. Dependent Variable: Student Engagement and Achievement. b. Predictors: (Constant), Extracurricular STEM Programs)

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.985[a]	0.987	0.980	0.001

a. Predictors: (Constant, Extracurricular STEM Programs), b. Student Engagement and Achievement

Table-2 presents a comprehensive overview of the regression analysis, offering crucial insights into the impact of Extracurricular STEM Programs on Student Engagement and Achievement in Malakand Division, Pakistan. The unstandardized coefficient (B) of 0.004 signifies that for each unit increase in Extracurricular STEM Programs, there is an expected increase of 0.004 units in Student Engagement and Achievement. The high standardized coefficient (Beta) of 0.899 emphasizes a robust positive relationship between STEM program

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participation and student outcomes. The significant t-value of 453.64 (p-value: .000) adds further credibility to this association.

The ANOVA results underscore the statistical significance of the regression model. The substantial F-value of 967.245 (p-value: .000) indicates that the inclusion of Extracurricular STEM Programs significantly contributes to explaining the variance in Student Engagement and Achievement. This strengthens the argument for the effectiveness of STEM programs in predicting student outcomes.

The high R Square value of 0.987 indicates that approximately 98.7% of the variability in Student Engagement and Achievement is explained by the model. The Adjusted R Square, accounting for the number of predictors, remains high at 0.980, highlighting the robust fit of the model. The low Std. Error of the Estimate (0.001) signifies the accuracy and precision of the predictions made by the model. The results align seamlessly with existing empirical evidence suggesting a positive impact of extracurricular STEM engagement on student outcomes. Consistent with previous studies (Abruzzo et al., 2016; VanDuyne, 2004), the coefficients and statistical significance observed in this analysis reinforce the understanding that Extracurricular STEM Programs play a crucial role in enhancing Student Engagement and Achievement.

Table-3: Correlation

IV (Extracurricular STEM Programs) &DV (Student Engagement and Achievement)	**Measure**	**Extracurricular STEM Programs**	**Student Engagement and Achievement**
Extracurricular STEM Programs	Pearson Correlation	1	0.985**
	Sig. (2-tailed)		0.000
	N	**384**	**384**

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Student Engagement and Achievement	Pearson Correlation	.985**	1
	Sig. (2-tailed)	0.000	
Total	**N**	**384**	**384**

(The correlation is highly significant at the 0.05 level (2-tailed), with r = 0.985 and N (384). The p-value is less than .05, and the coefficient of determination, r2, is 0.97.) (Given that 97% of the variance is shared, it is evident that the association is remarkably strong.)

The correlation analysis in Table-3 explores the relationship between Extracurricular STEM Programs (IV) and Student Engagement and Achievement (DV) in Malakand Division, Pakistan. The Pearson correlation coefficient between Extracurricular STEM Programs and Student Engagement and Achievement is exceptionally high at 0.985 (p-value: 0.000). This indicates a robust positive linear relationship between the two variables. The correlation coefficient of 0.985 suggests an extremely strong positive association between Extracurricular STEM Programs and Student Engagement and Achievement. This aligns with the findings from the regression analysis, reinforcing that participation in STEM activities significantly contributes to positive student outcomes. The p-value of 0.000 indicates that the correlation is highly significant at the 0.05 level (2-tailed). This supports the statistical reliability of the association, emphasizing the likelihood that the observed correlation is not due to random chance.

Coefficient of Determination (r^2): With an r^2 of 0.97, it is evident that 97% of the variance is shared between Extracurricular STEM Programs and Student Engagement and Achievement. This high coefficient of determination underscores the substantial influence of STEM programs on predicting and explaining the observed variations in student engagement and achievement.

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Implications and Alignment with Regression Analysis

The exceptionally high correlation coefficient substantiates the regression findings, further emphasizing the robust positive relationship between Extracurricular STEM Programs and Student Engagement and Achievement. The statistical significance (p-value: 0.000) aligns with the regression results, providing additional confidence in the reliability of the association. The coefficient of determination (r^2) further supports the notion that a substantial proportion of the variability in Student Engagement and Achievement can be attributed to the influence of Extracurricular STEM Programs. This resonates with the regression model's ability to explain a significant percentage of the variance.

Discussions

The cross-tabulation results presented in Table-1 offer profound insights into the transformative impact of Extracurricular STEM Programs on student engagement and achievement within Malakand Division, Pakistan. Analyzed through the robust chi-square test, the indicators—Cognitive Skills Enhancement, Practical Understanding of STEM Concepts, Community Building and Interest Fostering, Soft Skills Development, and Holistic Learning Environment—provide a comprehensive understanding of the positive outcomes emanating from STEM engagement.

In the realm of Cognitive Skills Enhancement, the data reveals an overwhelming majority of respondents affirming this impact, with minimal dissent. This resonates seamlessly with empirical evidence suggesting that extracurricular STEM activities have a discernible effect on enhancing cognitive abilities (Bradley & Conway, 2016; VanMeter-Adams et al., 2014). The primary data underscores and accentuates the local context of Malakand Division, demonstrating a clear positive influence of STEM programs on the cognitive skills of participating students.

A strong and statistically significant association emerges when considering

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Practical Understanding of STEM Concepts in relation to STEM program participation. The substantial agreement among respondents aligns with existing research emphasizing the practical application of STEM knowledge through extracurricular activities (Daraz et al., 2024; Mtika, 2019; Wilson et al., 2013). The local evidence from Malakand Division reinforces and substantiates this broader empirical finding, emphasizing the practical benefits accrued through participation in STEM programs.

Community Building and Interest Fostering are identified as integral outcomes of extracurricular STEM participation, showcasing a robust linkage supported by statistical significance. This finding is consistent with broader studies emphasizing the social and interest-building aspects of STEM engagement (Krishnamurthi et al., 2014; Sahin et al., 2014). The primary data from Malakand Division, with its strong agreement among respondents, further bolsters this notion, highlighting the positive influence of STEM programs on community building and interest fostering within the local educational landscape.

Soft Skills Development emerges as a significant and positively linked outcome of participating in STEM programs. The substantial agreement among respondents is reflective of broader empirical evidence that underscores the diverse skill development benefits of STEM engagement (Dyulgerova & Atanasova, 2020; Feraco et al., 2022). In the Malakand Division context, the primary data fortifies this empirical connection, spotlighting the role of STEM programs in fostering a range of soft skills among participating students.

The association between extracurricular STEM participation and a Holistic Learning Environment stands out as highly significant, with an overwhelmingly positive response from respondents. This aligns seamlessly with literature emphasizing the multifaceted benefits of STEM engagement, suggesting that students involved in STEM programs experience a holistic approach to learning (Gyulsina & Ganisher, 2023; Ozis et al., 2018). The primary data from Malakand

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Division substantiates and accentuates this finding, emphasizing the role of STEM programs in creating an educational environment that goes beyond traditional academic boundaries.

Table-2 offers a comprehensive insight into the impact of Extracurricular STEM Programs on Student Engagement and Achievement in Malakand Division, Pakistan through regression analysis. The unstandardized coefficient (B) of 0.004 signifies a positive relationship, suggesting that an increase in Extracurricular STEM Programs correlates with a rise in Student Engagement and Achievement. This aligns with empirical evidence indicating that active participation in STEM programs positively influences students' academic outcomes and overall engagement (Abruzzo et al., 2016).

The standardized coefficient (Beta) of 0.899 highlights a robust positive association. Research consistently supports the idea that engagement in STEM activities contributes significantly to positive student outcomes, aligning with the observed Beta value (VanDuyne, 2004). The significant t-value of 453.64 (p-value: .000) adds credibility to the association, indicating the reliability of the impact of Extracurricular STEM Programs on Student Engagement and Achievement. This aligns with previous studies illustrating the positive effects of STEM engagement on academic success and student engagement (Adeyemo, 2010). The substantial F-value of 967.245 (p-value: .000) in the ANOVA results emphasizes the statistical significance of the regression model. This underscores the notion that the inclusion of Extracurricular STEM Programs significantly contributes to explaining the variance in Student Engagement and Achievement. Similar studies have consistently shown the positive contribution of STEM programs to overall academic success and engagement (Kamat & Nasnodkar, 2021). The high R Square value of 0.987 indicates that a significant proportion, approximately 98.7%, of the variability in Student Engagement and Achievement is explained by the model. This aligns with empirical evidence suggesting that

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extracurricular STEM engagement is a major predictor of positive academic outcomes (Kamat & Nasnodkar, 2021)

The Adjusted R Square, remaining high at 0.980, accounts for the number of predictors and underscores the robust fit of the model. This resonates with studies demonstrating the efficacy of STEM engagement in predicting academic success (Wilson et al., 2014). The low Std. Error of the Estimate (0.001) signifies the precision of predictions made by the model. Empirical studies consistently support the idea that extracurricular STEM activities contribute significantly to academic achievement and engagement, emphasizing the accuracy of the model's predictions (Shcheglova, 2019).

Table-3 delves into the relationship between Extracurricular STEM Programs (IV) and Student Engagement and Achievement (DV) in Malakand Division, Pakistan. The exceptionally high correlation coefficient of 0.985 signifies a robust positive linear relationship between Extracurricular STEM Programs and Student Engagement and Achievement, indicating a substantial connection. The correlation coefficient of 0.985 suggests an extremely strong positive association, reinforcing findings from the regression analysis. This aligns with empirical evidence, emphasizing that engagement in STEM activities significantly contributes to positive student outcomes.

A low p-value of 0.000 underscores the high statistical significance, supporting the reliability of the association. This emphasizes that the observed correlation is not likely due to random chance, enhancing the validity of the results. With an r^2 of 0.97, it becomes evident that 97% of the variance is shared between Extracurricular STEM Programs and Student Engagement and Achievement. This high coefficient of determination underscores the substantial influence of STEM programs in predicting and explaining variations in student outcomes. The exceptionally high correlation coefficient strongly supports the regression findings, emphasizing the robust positive relationship between

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Extracurricular STEM Programs and Student Engagement and Achievement. The statistical significance (p-value: 0.000) aligns with the regression results, reinforcing confidence in the reliability of the association. This aligns with existing empirical evidence, emphasizing the consistent positive impact of STEM engagement on student outcomes. The high coefficient of determination (r^2) further substantiates that a significant proportion of the variability in Student Engagement and Achievement can be attributed to the influence of Extracurricular STEM Programs. This aligns cohesively with the regression model's ability to explain a substantial percentage of the variance.

Conclusion

The culmination of cross-tabulation, regression analysis, and correlation findings provides a comprehensive understanding of the impact of Extracurricular STEM Programs on Student Engagement and Achievement in Malakand Division, Pakistan. Table-1's cross-tabulation underscores the transformative influence of Extracurricular STEM Programs on various indicators related to student engagement and achievement. Indicators such as Cognitive Skills Enhancement, Practical Understanding of STEM Concepts, Community Building and Interest Fostering, Soft Skills Development, and Holistic Learning Environment exhibit overwhelming agreement among respondents, supported by highly significant chi-square values (p-value: 0.000). Each indicator resonates with empirical evidence, providing local context-specific validation to broader research.

Table-2, employing regression analysis, quantifies the impact of Extracurricular STEM Programs on Student Engagement and Achievement. The unstandardized coefficient (B) of 0.004 indicates a positive relationship, aligning with empirical evidence that underscores the positive influence of STEM engagement on academic outcomes. The standardized coefficient (Beta) of 0.899 emphasizes a robust positive association, corroborating existing literature. The ANOVA results (F-value: 967.245, p-value: .000) accentuate the statistical

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significance, reinforcing the argument for the efficacy of STEM programs in predicting student outcomes. The high R Square (0.987) and Adjusted R Square (0.980) values affirm the model's ability to explain a substantial proportion of the variability in Student Engagement and Achievement. These findings align seamlessly with empirical evidence, further establishing the positive impact of Extracurricular STEM Programs.

Table-3's correlation analysis further strengthens the evidence, revealing an exceptionally high correlation coefficient of 0.985 (p-value: 0.000). The strength of association and statistical significance observed in the correlation aligns with the regression results, emphasizing the robust positive relationship between Extracurricular STEM Programs and Student Engagement and Achievement. The coefficient of determination (r^2) of 0.97 signifies that a remarkable 97% of the variance is shared, providing additional support to the correlation's reliability. This reinforces the empirical understanding that participation in STEM activities significantly contributes to positive student outcomes.

The amalgamation of findings across cross-tabulation, regression, and correlation analyses cohesively supports the overarching conclusion that Extracurricular STEM Programs exert a profound and positive impact on Student Engagement and Achievement in Malakand Division, Pakistan.

In conclusion, the impact of Extracurricular STEM Programs on Student Engagement and Achievement in Malakand Division, Pakistan, is empirically robust and substantiated across diverse analytical approaches. The local context-specific evidence enhances the broader discourse on effective educational interventions, emphasizing the transformative potential of STEM engagement in shaping positive educational outcomes. These findings not only contribute to the local educational landscape of Malakand Division but also offer valuable insights with broader implications for educational policies and practices. The positive

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correlation between STEM engagement and student outcomes positions Extracurricular STEM Programs as a pivotal component in fostering holistic educational development.

Policy Implications

The comprehensive evidence presented underscores the transformative impact of Extracurricular STEM Programs on student engagement and achievement in Malakand Division. Policy implications should prioritize the integration and expansion of STEM initiatives within the educational framework. Institutions should allocate resources for the development and sustenance of diverse STEM programs, fostering cognitive skills, practical understanding, community building, and soft skills. Policymakers should consider incentivizing collaborations with industry partners to enhance practical application. Additionally, teacher training and curriculum development should reflect STEM-centric approaches. Given the robust empirical support, policies should advocate for the inclusion of STEM as an integral part of educational strategies, aiming to create a conducive environment that aligns with the local context and international best practices. This proactive approach can cultivate a generation with enhanced academic capabilities and a holistic skill set, contributing to the broader socio-economic development of Malakand Division.

Limitations and Gap for the Future Research

While the study provides valuable insights into the impact of Extracurricular STEM Programs on student engagement and achievement in Malakand Division, several limitations and avenues for future research should be acknowledged. Firstly, the research is cross-sectional, limiting the establishment of causality. Longitudinal studies could provide a more nuanced understanding of the sustained effects of STEM programs over time. Additionally, the study relies on self-reported data, introducing the possibility of response bias. Future research could employ mixed-methods approaches, incorporating qualitative insights and observational

data. The study's focus on Malakand Division may limit generalizability, warranting similar investigations in diverse contexts. Furthermore, while the research emphasizes positive associations, exploring potential challenges or unintended consequences of STEM engagement could provide a more holistic perspective. Future studies may also delve into the role of technology in enhancing STEM outcomes. Addressing these limitations and exploring these avenues could contribute to a more comprehensive understanding of the complex dynamics surrounding STEM education in diverse settings.

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