Bagiswori Journal
Vol. 5, No.1, April, 2026, Pages : 43 - 61
ISSN: 2676-1076 (Print), ISSN: 3021-9582 (Online)
DOI: https://doi.org/10.3126/bagisworij.v5i1.93464

Impact of Extracurricular and Co-curricular Activities on Students' Motivation toward Learning Science: A Gender-Based Analysis

Umanath Lamsal
Assistant Professor
Sanothimi Campus, Tribhuvan University, Bhaktapur, Nepal
uma.lamsal@sac.tu.edu.np

Received: 2026/2/1 Revised: 2026/2/12 and 2026/4/8 Accepted: 2026/4/21

Abstract

The study investigated how Structured Extracurricular Activities (ECA) and Co-curricular Activities (CCA) programs affected the secondary level students' motivation toward learning science on the basis of gender. The study employed a quasi-experimental study which included a non equivalent control group design that did not receive equivalent treatment to test 136 students of Grade IX from two schools in Kathmandu Valley, Nepal. The experimental group (n = 70; 30 boys and 40 girls) participated in a structured 8-month ECA/CCA intervention comprising 12 science-based activities, while the control group (n = 66; 42 boys and 24 girls) followed the standard national science curriculum without any structured intervention. Pre-testing with the Science Motivation Questionnaire II (SMQ-II) which assesses five motivational subscales: Intrinsic Motivation, Self-Efficacy, Self-Determination, Grade Motivation, and Career Motivation, standardized both groups. The experimental group demonstrated a statistically significant boost in total science motivation when compared with the control group as evidenced by post-test results ($t(134) = 4.18$, $p < 0.001$, Cohen's $d = 0.74$). The two-way ANOVA demonstrated a significant effect of ECA, CCA, ($F(1,132) = 5.87$, $p = 0.017$) which showed that female students in the experimental group achieved greater motivational improvement than male students. The structured ECA/CCA experiences led to the most significant improvements in Self-Efficacy and Career Motivation for female students, showing that this method effectively addresses science motivation gaps between genders. Secondary school science education benefits from experiential learning programs because they increase student motivation and help achieve gender balance in STEM disciplines.

Keywords: co-curricular activities, extracurricular activities, gender analysis, science motivation, quasi-experimental study, STEM education

1. Introduction

The critical psychological determinants are recognized for science motivation, which drives students' persistence, engagement, and achievement in science education (Tuan et al., 2005; Glynn et al., 2011). Students' motivation to learn science experiences a worldwide decline which becomes more severe during their adolescence period that is globally observed and concerning trend (Osborne et al., 2003; Vedder-Weiss & Fortus, 2012). This declination in motivation level to learn science has far-reaching consequences, not only for students' immediate academic achievement but also for their long-term aspirations to pursue careers in the field of Science, Technology, Engineering, and Mathematics (STEM) (Maltese & Tai, 2010).

The South Asian region, particularly in the context of Nepal acute this problem as a major difficulty or an issue. The National Curriculum Framework (CDC, 2007) and the School Education Sector Plan (MoE 2016 to 2023) establish study science subject is as a mandatory requirement as a compulsory subject upto the Grade X. However, involvement in learning science at the higher secondary level (Grade XI and XII) and in university science programs (STEM-oriented programs) remains consistently low, especially among female students (ERO, 2020; Varma et al., 2023). The research conducted in the South Asian region has identified three primary obstacles which prevent students from studying science: cultural factors, inadequate access to labs, and the use of lecture-based teaching methods as the main instructional approach (Sharma, 2009). The absence of hands-on learning experiences and science engagement, in Nepalese classrooms demands a critical need for innovative pedagogy that can supplement content-based instruction.

The academic achievement gaps between genders have decreased yet girls consistently presented lower science self-efficacy and career motivation than boys (Britner & Pajares, 2006; Wang & Degol, 2017). This disparity is influencing through social and cultural factors, differential expectations, and a lack of visible female role models in science (Hyde, 2014). In the Nepalese context, patriarchal social norms and family pressures teacher and peers of the girl students was minimum. Despite of this, the Girl's motivation toward learning science is showing higher than their achievement (Aryal, 2019). The learning obstacles which students face need dedicated teaching methods which will create fair access to educational resources that benefit every student.

The combination of Extracurricular Activities (ECA) and Co-curricular Activities (CCA) creates an effective solution as promising approach. Extracurricular Activities (ECA) and Co-curricular Activities (CCA) represent one such promising approach. ECA refers to voluntary science-related pursuits that are conducted out of school and out of formal class hours, such as science and environment clubs, independent science projects and science olympiads, that nurture students' personal interests and foster scientific identity (Furda & Shuleski, 2019; Lauer et al., 2006). While CCA, refers to well planned activities that are directly interrelated to the school curriculum or formal learning activities, such as science field trips, science fairs, and project-based learning modules, and are intentionally designed to reinforce and extend classroom instruction (Bartkus et al., 2012; Sahin, 2013). Both Extra-curricular and Co-curricular activities are grounded in the theoretical frameworks of experiential learning (Dewey, 1938) and social constructivism (Vygotsky, 1978), which posit that practically active, socially embedded learning experiences in meaningful learning environments promote knowledge construction and intrinsic motivation.

Scholars have conducted extensive research about how students' motivation and interest in learning activities of teaching and learning are affected by their participation in extracurricular and co-curricular activities. The research evidence shows that students acquire knowledge outside classrooms through structured activities which support their academic studies. The empirical research which demonstrated that students who participated in extracurricular activities experienced academic advancement and personal growth according to his findings. Zaman (2017) explored that the Extracurricular activities have a major impact on the academic success of students in the universities of Pakistan.

Annu and Sunita (2014) explored that students who take part in extracurricular activities experience positive effects on their overall growth. The research demonstrated that the activities lead to better academic results and students developed essential social skills which helped them transition into adulthood plus they showed improved behavior patterns and their school completion rates increased. Annu and Sunita (2014) suggested that secondary education systems which lack structured extracurricular programs should make extracurricular activities a standard requirement for educational institutions based on their research findings. The educational system gains major benefits from these activities since they create better learning opportunities for students while making the school environment more positive and motivational.

The educational benefits of ECA and CCA programs receive backing from research studies. Research shows that students who take part in organized science ECAs and CCAs experience better academic results and increased interest in their subjects and improved research skills (Gottfried & Williams, 2013; Lauer et al., 2006). The activities fulfill all three basic psychological requirements that Self-Determination Theory (SDT) states are essential for people to maintain their ability to learn through self-motivation. (Ryan & Deci, 2020).

2. Research Gap

Despite the existing evidence, a significant research gap still remains. First, there has been insufficient research through quasi-experimental studies which should assess how structured ECA/CCA programs affect science motivation by using the Science Motivation Questionnaire II (Glynn et al., 2011) as a validated assessment tool. Second, the motivational experiences of Nepalese secondary school students, particularly how boys and girls experience different outcomes remain largely unexplored in published literature. The present study addresses both of these gaps.

3. Research Objectives

The present study was guided by the following specific objectives:

1. To examine the effect of structured ECA/CCA on secondary level students' motivation to learn science.
2. To compare the level of motivation to learn science between boys and girls of the experimental and control group in Extra-curricular and Co-curricular science activities.

4. Research Questions

1. Is there a difference in motivation to learn science between students of Experimental group in Extra-curricular and Co-curricular science activities and Control group?
2. Does gender (boys vs. girls) influence motivation to learn science among students of Experimental group in Extra-curricular and Co-curricular science activities compared to Control group?

5. Literature Review

The section assesses theoretical frameworks together with empirical literature which supports the study through three main themes. The three main themes of the study focus on (1) experiential and constructivist learning theories (2) self-determination theory and science motivation (3) gender disparities in science motivation.

5.1 Experiential Learning and Social Constructivism

The study's theoretical framework utilizes theory of experiential learning (Dewey, 1938) and social constructivism theory (Vygotsky, 1978) as its main theoretical basis. Dewey believed that education should begin from students' real-life experiences because students learn best when they connect with their learning surroundings. Vygotsky extended this concept by focusing the social interactions function as essential elements for human cognitive development while students learn within zone of proximal development through interactions with peers and skilled adults who help them comprehend new information. The Extracurricular and co-curricular activities create real-life scientific experiences which help students apply science in social settings outside their classroom learning time.

5.2 Self-Determination Theory and Science Motivation

The research base for this study relies on Self-Determination Theory which was documented by Ryan and Deci in their 2020 publication. SDT posits that humans have three basic psychological needs autonomy competence and relatedness, which must be satisfied to achieve intrinsic motivation. Glynn et al. (2011) developed the Science Motivation Questionnaire II (SMQ-II) which measures motivation through five distinct subscales: Intrinsic Motivation Self-Efficacy Self-Determination Career Motivation and Grade Motivation. The research shows that science programs which meet SDT requirements lead students to engage in deeper learning while maintaining their commitment to scientific studies (Ryan & Deci, 2020).

5.3 Gender Disparities in Science Motivation

The motivational differences between genders lead to different levels of scientific engagement which scientists have studied extensively. Girls show lower science self-efficacy and career motivation compared to boys because social norms and different expectations and the lack of visible female STEM role models exist (Britner & Pajares, 2006; Hyde, 2014; Wang & Degol, 2017). Patriarchal cultural norms and family expectations create additional obstacles which Nepalese people must overcome (ERO, 2020; Varma et al., 2023). Sharma (2025) found that girls in Indian secondary schools gain motivational advantages from participating in practical science activities. Aryal (2019) discovered that Nepalese secondary students developed greater science interest through their experiential learning activities. Collaborative project-based learning environments provide girls with particular advantages because these environments enable girls to showcase their scientific skills in equitable ways (Britner & Pajares, 2006; Wang & Degol, 2017). Shrestha and Pradhan (2025) demonstrated that students who participated in co-curricular activities at Kathmandu Valley universities experienced higher motivation and better academic performance. The evidence collected supports the need for a structured SDT-based ECA/CCA program which helps decrease gender-based motivation differences between students.

6. Methodology

6.1 Research Design

The study used a quasi-experimental study which included a non-equivalent control group design. The design becomes necessary when researchers cannot randomly assign participants to different groups in their studies which occurs frequently in actual school environments. The researchers selected two secondary schools from Kathmandu Valley Nepal which had similar socio-economic student profiles and both schools provided equal access to fundamental science laboratory resources. The researchers established group equivalence before the study by using independent samples t-tests to compare pre-intervention SMQ-II scores which showed no statistical differences across all five subscales ($p > 0.05$ for all) which confirmed both groups started with equal motivational levels. The researchers established one school as the experimental site while designating the other school as the control site to prevent any potential contamination between the different experimental conditions.

6.2 Participants

The study included 136 students as participants from Grade IX who were aged between 14 and 16 years from two secondary schools located in Kathmandu Valley, Nepal. Following Cohen’s (1988) statistical power analysis framework was used. The minimum required sample size for each group was approximately 63 students. The formula used for estimating the sample size for comparing two independent means is:

$$n = \frac{(Z_{\alpha/2}+Z_{\beta})^2}{d^2}.$$

The researchers used purposive sampling to select participants based on the following criteria: (a) students at both schools shared similar socioeconomic backgrounds according to school records and principal interviews; (b) both schools possessed equivalent basic laboratory facilities; (c) students at both schools had similar science achievement levels according to their Grade VIII final examination scores; and (d) both schools had no prior history of science related structured ECA/CCA programs. The researchers assigned intact classes from each school to specific conditions which matched the requirements of the quasi-experimental design. The experimental group included 70 students who consisted of 30 boys and 40 girls while the control group included 66 students who consisted of 42 boys and 24 girls. Both schools followed the National curriculum framework developed by the Curriculum Development Centre (CDC) of Nepal.

Students and their guardians gave informed consent before the school obtained voluntary participation from students. The researchers provided all study participants with complete information about the research study's purpose and their right to withdraw from the study and their right to keep their survey answers confidential. The institutional review board of the author's organization (Dean's office, FOE, TU) approved the study after receiving ethical approval for research activities.

6.3 Intervention

The experimental group underwent an 8-month ECA/CCA program which included 12 sequenced science-based activities that followed during the complete academic year. The activities were developed according to Self-Determination Theory principles (Ryan & Deci, 2020) which intended to help students achieve their three essential psychological needs of autonomy and competence and relatedness that lead to intrinsic motivation. The researcher and classroom science teacher implemented the program after receiving two days of orientation training before the intervention. The activities were designed to help students develop their skills and confidence while they worked with others, which led to their final presentation at a public science exhibition jointly organized by Madhyapur Thimi Municipality and Experimental school of Bhaktapur district. The list of ECA, CCA is presented as intervention activities presented below.

The control group continued with the standard Grade IX national science curriculum as prescribed by the CDC Nepal, without any structured ECA or CCA components beyond regular classroom instruction. The structured ECA/CCA Intervention Program is summarized in Table 1.

Table 1

Structured ECA/CCA Intervention Program

Month	Core Intervention Activities	Primary Science Motivation Target

1–2	Science & Environment Club (ECA); Science Gallery Visit and Gallery Preparation (CCA)	Building relatedness; Sparking curiosity (Intrinsic Motivation)
3	Science Field Trip (ECA); Science Seminar (ECA)	Enhancing relevance (Intrinsic/Career Motivation)
4	Science Quiz & Debate (ECA/CCA); Science Gamification (CCA)	Fostering mastery in low-risk settings (Self-Efficacy)
5	Intensive Science Practical Activities (SPA)	Building hands-on procedural confidence (Self-Efficacy)
6	Model Design Competition (CCA); Sci-Tech Talk (ECA)	Applying knowledge creatively (Self-Determination, Career Motivation)
7–8	Science Exhibition Project (ECA); School Science Parade (ECA)	Showcasing mastery; fostering pride and science identity (Self-Efficacy, Career Motivation)

Note. ECA- Extracurricular Activity; CCA- Co-curricular Activity; SPA- Science Practical Activities.

6.4 Instrument and data collection

The Science Motivation Questionnaire II SMQ-II was used to assess science motivation because it is a validated instrument that developed Glynn et al. (2011). The SMQ-II includes 25 items which are divided into five subscales that each contain five items: (1) Intrinsic Motivation, (2) Self-Efficacy, (3) Self-Determination, (4) Grade Motivation, and (5) Career Motivation. The assessment uses a five-point Likert scale which allows respondents to rate each item from 1 (Never) to 5 (Always). Each subscale can achieve scores which range from 5 to 25 while the total motivation score for the assessment can reach between 25 to 125 points. The SMQ-II was chosen because it demonstrates excellent psychometric characteristics which include high high internal consistency (Cronbach's $\alpha = 0.89$ to 0.93 across subscales) and evidence of construct validity with secondary and post-secondary student populations (Glynn et al., 2011). Permission for its use was obtained directly from the instrument developers prior to administration.

The SMQ-II was administered as a pre-test to both groups prior to the intervention and as a post-test upon the completion of the 8-month program. AI tools and a bilingual education expert translated the instrument into Nepali and then back-translated it into English to verify its accuracy according to standard cross-cultural adaptation procedures. The research team conducted a pilot test of the Nepali version with 20 Grade IX students from a school not included in the main study. The pilot test produced a Cronbach's α of 0.87 which confirmed the Nepali version's reliability for the Nepalese context.

7. Data Analysis

Researchers used SPSS version 27.0 to perform all statistical analyses. The researchers calculated descriptive statistics which included means and standard deviations for all five SMQ-II subscales and total motivation scores of each group and gender subgroup. The researcher used Levene's test to confirm normality of the data which showed the Levene's test ($p > 0$ .05) for all subgroups and Levene's test showed that all groups had equal variance (Levene, 1960; Taber, 2018). The researchers established that t-test and ANOVA assumptions were fulfilled before conducting their analysis.

Independent samples t-test was used to compare post-test total SMQ-II scores between the experimental and control groups to measure how the intervention affected overall science motivation. The researcher used two-way ANOVA to study how boys and girls performed in their motivation after they were assigned to either the experimental or control groups. The researchers conducted post-hoc independent samples t-tests with Bonferroni correction to determine specific gender differences between groups and within groups after they found significant interaction effects. The researcher calculated Cohen's d effect sizes for all significant comparisons to determine practical significance by applying conventional benchmarks which define small effect size as $d = 0.2$ medium effect size as $d = 0.5$ and large effect size as $d = 0.8$ according to Cohen, (1988).

8. Result

8.1 Pre-Test Equivalence

The independent samples t-tests showed no significant differences between the experimental and control groups across all five SMQ-II subscales before the intervention (all $p >0$ .05). The pre-test total motivation scores showed no significant difference between the two groups (Experimental: $M = 71.8$, $SD = 8.4$; Control: $M = 72.3$, $SD = 7.9$; $t(134) = 0.36$, $p = 0.72$), which confirmed baseline equivalence and further established the internal validity of the following comparisons.

8.2 Overall Effect of ECA/CCA on Science Motivation

The results of an independent samples t-test showed that post-test total motivation scores differed significantly between the experimental group who had mean score of 78.2 and standard deviation of 7.5 and the control group who had mean score of 74.0 and standard deviation of 7.4. The effect size measurement showed a medium-to-large effect which demonstrated that ECA/CCA intervention produced substantial improvements in students science motivation. The experimental group achieved a post-test average score which surpassed the control group by 4.2 points on the 125-point SMQ-II scale. This finding demonstrates a significant improvement in science motivation which resulted from the structured intervention program.

8.3 Gender-Based Analysis

The study used a two-way ANOVA with Group and Gender as independent variables which showed a significant interaction effect between Group and Gender through statistical results of $F(1, 132) = 5.87$ and p value of 0.017 and partial η^2 value of 0.04. The ECA/CCA program created different motivational impacts according to the students' gender because female students gained more from the program than their male counterparts. The group main effect also reached statistical significance, $F(1, 132) = 17.48$, $p < 0.001$, partial $\eta^2 = 0.12$, while the gender main effect did not reach significance, $F(1, 132) = 1.23$, $p = 0.27$, indicating that motivation differences between genders emerged specifically through their group membership (i.e., intervention participation) rather than through gender alone.

The post-hoc independent samples t-tests which used Bonferroni correction showed that girls from the experimental group outperformed their control group counterparts in motivation scores during the post-test assessment ($p < 0.001$, Cohen's $d = 0.91$), which demonstrated a large effect size. The experimental group of boys achieved better results than their control group counterparts ($p < 0.05$, Cohen's $d = 0.48$) who showed a medium-sized effect. The experimental group showed that boys reached higher Self-Efficacy and Self-Determination subscale scores whereas girls obtained total motivation scores which exceeded boys due to their major advances in Career Motivation and overall composite score improvement.

8.4 Subscale Analysis

The table 2 provides information about the results of post-test assessments which includes descriptive statistics for each SMQ-II subscale divided by groups and gender together with essential pairwise comparisons which were conducted within the experimental group. The second research question revealed that Self-Efficacy and Career Motivation produced the most significant differences between study groups while Grade Motivation showed the least improvement. The intervention developed autonomous (intrinsic) motivation through authentic interest and perceived competence which aligns with SDT principles (Ryan & Deci, 2020) because it developed intrinsic motivation and not extrinsic grade-dependent motivation. The hands-on Science Practical Activities in Month 5 and the Science Exhibition Project in Months 7–8 provided authentic public mastery experiences which Bandura (1997) identified as the primary source of self-efficacy construction.

Table 2

Post-Test Motivation Subscale Scores (M and SD) and Key Gender Comparisons

Motivational Subscale	Control Boys M (SD)	Control Girls M (SD)	Exp. Boys M (SD)	Exp. Girls M (SD)	Key Gender Comparison (Within Exp. Group)
Intrinsic Motivation	14.9 (3.3)	14.9 (2.4)	15.1 (2.2)	14.8 (2.2)	No significant difference ($p > 0.05$)
Self-Efficacy	13.5 (3.1)	13.3 (2.2)	14.4 (2.5)	12.8 (2.7)	Boys > Girls ($p < 0.05$)
Self-Determination	13.6 (2.3)	13.7 (2.2)	14.2 (2.0)	13.2 (2.4)	Boys > Girls ($p < 0.05$)
Career Motivation	15.2 (3.6)	16.4 (2.2)	16.2 (3.5)	15.4 (2.9)	Girls ≈ Boys; both significantly above control ($p < 0.05$)
Grade Motivation	15.8 (2.8)	16.2 (2.3)	16.5 (2.5)	15.6 (2.6)	No significant difference (p >

					0.05)
Total Motivation	73.1 (8.1)	75.2 (6.5)	79.4 (7.8)	76.8 (7.2)	Significant Group × Gender Interaction ($F(1,132) = 5.87$, $p = 0.015$); Girls in Exp. > Girls in Control ($d = 0.91$)

Note. M = Mean; SD = Standard Deviation; Exp. = Experimental. Post-hoc comparisons used Bonferroni correction.

9. Discussion

The results show that the structured, 8-month ECA/CCA program increased secondary students' science learning motivation to a significant level. The intervention achieved a medium-to-large effect size (Cohen’s d = 0.74) which matched the results of previous international studies on similar interventions (Lauer et al., 2006; Gottfried & Williams, 2013). The SDT-based program produced these results because it fulfilled student autonomy needs through project work and competence needs through progressive mastery experiences and it fulfilled student relatedness needs through team activities which Ryan and Deci (2020) identified as essential elements of intrinsic motivation. The study by Shrestha and Pradhan (2025) found that students who took part in co-curricular activities built stronger connections to their institution which led to increased motivation and decreased academic disengagement. Students who take part in various co-curricular activities such as clubs and science fairs and community service and project-based modules develop leadership and teamwork and critical thinking abilities which help them achieve academic success (Annu & Sunita, 2014).

The improvement pattern observed at subscale levels reveals how the intervention resulted in changes to participant motivation. The control group showed the least improvement in Grade Motivation while Self-Efficacy and Career Motivation demonstrated the most significant improvement. The ECA/CCA program established autonomous self-directed motivation which develops from actual interest and perceived competence as its primary outcome instead of the program simply raising grade-dependent external motivation levels. The distinction matters because autonomous motivation leads to deeper learning and more persistent science study habits than controlled motivation does (Glynn et al., 2011; Ryan & Deci, 2020). The hands-on Science Practical Activities in Month 5 and the Science

Exhibition Project in Months 7–8 provided authentic public mastery experiences that represent Bandura's (1997) concept of enactive mastery as the primary source of self-efficacy construction.

The study discovered its most critical and complex result about how the intervention affected different genders. The Group and Gender interaction showed statistical significance because the ECA/CCA program created different results for male and female students, with girls receiving much higher benefits from the program. The finding holds special significance because Nepal and South Asian countries still have gender disparities which stop women from entering scientific fields (Varma et al., 2023; ERO, 2020; UNICEF Nepal, 2018). Sharma (2025) established that every school activity girls engaged in, especially through ECA and CCA, resulted in higher learning motivation for them.

The differential benefits which girls receive can be explained through different educational theories which work together with each other. The research by Wang and Degol (2017) shows that traditional Nepalese classroom settings disadvantages girls because lecture-based teaching methods limit their chances to participate actively and show their understanding of science as a social practice. The ECA/CCA program which uses collaborative project-based learning created an educational environment that treated all students equally by allowing girls to prove their scientific skills which served as essential requirement for developing their science self-efficacy (Britner & Pajares, 2006). The Science Field Trip and Sci-Tech Talk with various role models and Science Exhibition activities established direct links between scientific knowledge and real-world social problems which studies show motivates girls who view social usefulness and community values as crucial elements in their career choices (Wang & Degol, 2017; Hyde, 2014). The experiences from these activities helped to increase Career Motivation among female students at a strong level. The activities which required teamwork and social interaction created an environment full of connections which helped girls sustain their motivation according to previous research findings about how different genders react to social need fulfillment (Ryan & Deci, 2020).

The experimental group showed boys who participated in the study to achieve better results on both Self-Efficacy and Self-Determination subscales. The Science Quiz and Model Design Competition as competitive activities provided male students who already showed higher confidence in their competitive abilities with better results (Britner & Pajares, 2006). The program needs future revisions which should include structured mentoring and cooperative learning components to help girls develop self-efficacy in competitive environments. The analysis of subscales shows that girls have higher total motivation and Career Motivation scores while boys achieve better results on specific subscales which highlights the need for subscale-level analysis to identify motivational trends that aggregate scores hide and to develop more effective teaching strategies.

The current results match existing research from South Asia while adding new findings to this area of study. Aryal (2019) found that students who participated in hands-on learning activities developed greater interest in science but his research lacked a validated motivation assessment tool and failed to present separate results for male and female students. Sharma (2025) found that Indian secondary school girls improved their motivation through practical science involvement but his study lacked a control group for comparison. The South Asian research base receives improved evidence through the present study which uses a quasi-experimental design and validated SMQ-II instrument and conducts gender-intersectional analysis.

10. Conclusion

The research demonstrates that structured Extracurricular Activities (ECA) and Co-curricular Activities (CCA) constitute effective and practically significant pedagogical strategies for increasing secondary level students' motivation toward learning science in the educational system of Nepal. The 8-month SDT-aligned intervention which included 12 activities produced a medium-to-large effect on science motivation while it specifically enabled equal motivational development through larger gains for female students. The educational benefit of the intervention emerges as its capacity to develop autonomous motivational forms through Self-Efficacy and Career Motivation which lead to deep engagement and STEM field persistence.

The research findings carry immediate practical benefits to Nepalese educational environments which are experiencing decreased science motivation and ongoing gender disparities in STEM participation and require adoption of new pedagogical innovation. The study shows that science programs which provide meaningful experiences and fulfill students' basic psychological needs can improve motivation in secondary classrooms especially for girls who have not benefited from traditional teaching methods.

11. Implications and Recommendations

For School Administrators: The school science program must establish structured ECA and CCA programs as essential resources which require full implementation.

Sustainable implementation requires dedicated timetable slots and budget allocation for materials and continuous science teacher professional development. The study recommends schools to plan and implement science related Activities -sequential model as a standardized model for their educational programs.

For Science Teachers: The ECA/CCA programs need to be developed through dedicated efforts to create educational programs which support all students and provide them with freedom. Teachers need to create learning activities which enable students to work together through practical experiences while showing different scientific career paths. The development of activities which help girls develop their confidence to compete in competitive environments needs to receive special focus through team-based contests and peer mentoring relationships and public acknowledgment of female scientific accomplishments.

For Policymakers: The Ministry of Education together with the Curriculum Development Centre of Nepal should establish a national framework system which provides schools with essential resources and benefits to develop their science ECA/CCA programs. Schools should include ECA and CCA programs in their assessment standards while education campuses should require teacher training programs to teach students how to create and implement experiential science learning experiences.

12. Limitations and Future Research

The study has several specific restrictions which need to be recognized. The research results which were obtained from the Kathmandu Valley, Nepal study with 136 participating students limit their application to other locations because the study used a particular cultural and geographical setting. The study used a quasi-experimental design because it was the best solution for its existing practical limitations, yet this method of research design prevents researchers from making reliable causal relationships between variables, which they could establish through a controlled study using random assignment. The study period fails to provide sufficient time for researchers to evaluate whether motivational improvements have permanent effects.

Researchers should attempt to replicate their study across diverse locations in Nepal and regions of South Asian regions to evaluate whether findings generalize across different socio-economic geographic and cultural environments. Studies with larger samples and, where feasible, randomized designs would strengthen causal inference. The academic field would greatly benefit from research on ECA and CCA participation, which examines how motivational growth leads to students' academic decisions and their selection of subjects for higher secondary education and STEM careers. Mixed-methods studies that combine student interviews with classroom observation will produce deeper explanations of how the intervention created its outcomes.

Conflict of Interest: The author declares no specific financial support and no known competing non-financial interests.

References

Al Kadri, H. H., Al Kadri, H., Ningrum, T. A., Santoso, Y., & Ratnawati, R. (2019). Planning for extracurricular activities. In *5th International Conference on Education and Technology (ICET 2019)* (pp. 381–384). Atlantis Press.

Annu, S., & Sunita, M. (2014). Extracurricular activities and student's performance in secondary school. *International Journal of Technical Research and Applications, 2*(6), 8–11.

Aryal, S. (2019). *Girls engagement and their achievement in science in Sindhupalchok District: A correlation study* (Doctoral dissertation, Central Department of Science and Environment Education), Tribhuvan University.

Bandura, A. (1997). *Self-efficacy: The exercise of control*. W. H. Freeman.

Bartkus, K. R., Nemelka, B., Nemelka, M., & Gardner, P. (2012). Clarifying the meaning of extracurricular activity: A literature review of definitions. *American Journal of Business Education, 5*(6), 693–704.

Britner, S. L., & Pajares, F. (2006). Sources of science self-efficacy beliefs of middle school students. *Journal of Research in Science Teaching, 43*(5), 485–499.

Cohen, J. (1988). *Statistical power analysis for the behavioral sciences* (2nd ed.). Lawrence Erlbaum Associates.

Curriculum Development Centre. (2007). *National curriculum framework for school education in Nepal*. Government of Nepal.

Dewey, J. (1938). *Experience and education. Macmillan.*

Education Review Office (2020). *National assessment of student achievement: Report on science at Grade 8*. Government of Nepal.

Furda, M., & Shuleski, K. (2019). Extracurricular activities and student outcomes: A review of the literature. *Journal of School Counseling*, *17*(8), 1–32.

Glynn, S. M., Brickman, P., Armstrong, N., & Taasoobshirazi, G. (2011). Science motivation questionnaire II: Validation with science majors and nonscience majors. *Journal of Research in Science Teaching*, *48*(10), 1159–1176.

Gottfried, M. A., & Williams, D. (2013). STEM club participation and STEM schooling outcomes. *Education Policy Analysis Archives, 21*(79).

Hyde, J. S. (2014). Gender similarities and differences. *Annual Review of Psychology, 65*(1), 373–398.

Lauer, P. A., Akiba, M., Wilkerson, S. B., Apthorp, H. S., Snow, D., & Martin-Glenn, M. L. (2006). Out-of-school-time programs: A meta-analysis of effects for at-risk students. *Review of Educational Research, 76*(2), 275–313.

Levene, H. (1960). Robust tests for equality of variances. In I. Olkin (Ed.), *Contributions to probability and statistics: Essays in honor of Harold Hotelling* (pp. 278–292). Stanford University Press.

Maltese, A. V., & Tai, R. H. (2010). Eyeballs in the fridge: Sources of early interest in science. *International Journal of Science Education, 32*(5), 669–685.

Ministry of Education (2016). *School sector development plan 2016–2023.* Government of Nepal.

Osborne, J., Simon, S., & Collins, S. (2003). Attitudes towards science: A review of the literature and its implications. *International Journal of Science Education, 25*(9), 1049–1079.

Ryan, R. M., & Deci, E. L. (2020). Intrinsic and extrinsic motivation from a self-determination theory perspective: Definitions, theory, practices, and future directions. *Contemporary Educational Psychology, 61*, Article 101860.

Sahin, A. (2013). STEM clubs and science fair competitions: Effects on post-secondary matriculation. *Journal of STEM Education, 14*(1), 5–11.

Shadish, W. R., Cook, T. D., & Campbell, D. T. (2002). *Experimental and quasi-experimental designs for generalized causal inference.* Houghton Mifflin.

Sharma, C. (2025). Laboratory anxiety: Prevalence and overcoming the challenges among Indian secondary school students. *SEAQIS Journal of Science Education, 5*(2), 47–54. https://doi.org/10.58249/sjse.v5i02.167.

Sharma, R. N. (2009). *Philosophy and sociology of education.* Surjeet Publications.

Shrestha, A., & Pradhan, R. S. (2025). Factors affecting student engagement in universities of Kathmandu Valley. *Nepalese Journal of Management, 12*(2), 1–15.

Taber, K. S. (2018). The use of Cronbach's alpha when developing and reporting research instruments in science education. *Research in science education*, *48*(6), 1273-1296.

Tuan, H. L., Chin, C. C., & Shieh, S. H. (2005). The development of a questionnaire to measure students' motivation towards science learning. *International Journal of Science Education, 27*(6), 639–654.

UNICEF Nepal. (2018). *Out-of-school children in Nepal: A situational analysis.* UNICEF.

Varma, R., Falk, J.H., & Dierking, L.D. (2023). Challenges and opportunities: Asian women in science, technology, engineering, and mathematics. *American Behavioral Scientist, 67*(9), 1063-1073.

Vedder-Weiss, D., & Fortus, D. (2012). Adolescents' declining motivation to learn science: A follow-up study. *Journal of Research in Science Teaching, 49*(9), 1057–1095.

Vygotsky, L. S. (1978). *Mind in society: The development of higher psychological processes*. Harvard University Press.

Wang, M.-T., & Degol, J. L. (2017). Gender gap in science, technology, engineering, and mathematics (STEM): Current knowledge, implications for practice, policy, and future directions. *Educational Psychology Review, 29*(1), 119–140.

Zaman, F. (2017). Positive impact of extracurricular activities on university students in Lahore, Pakistan. *International Journal of Social Sciences and Management, 4*(1), 22–31.