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Modelling Sustainable Mathematics Teaching and Learning in Nepal

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ABSTRACT

Sustainable mathematics education is crucial in the development of the sustained mathematical knowledge, confidence and understanding in real life contexts of students. However, mathematics learning in Nepal continues to be hindered by mathematics anxiety, having insufficient teaching resources, teacher-dominated teaching style, and an examination-driven assessment system. A few studies have looked at these

aspects separately, but few studies have taken into account cognitive, affective, pedagogical and contextual aspects together in a comprehensive framework for sustainable mathematics learning. This study aims to overcome this limitation by creating the model for sustainable mathematics teaching and learning in Nepali secondary school.

The convergent, mixed methods approach was used. 102 secondary level students from public and private schools were selected in Nepal for quantitative and qualitative data collection. The data were collected by using structured questionnaires, open-ended responses, interviews and classroom observations. Descriptive statistics, correlation, and multiple regression analysis were used to analyze quantitative data, and thematic analysis was used to analyze qualitative data.

The results indicated that there were negative relationships between mathematics anxiety and students' motivation, confidence, and involvement in mathematics learning. On the other hand, student-centered teaching method and learning environment and good use of contextual

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resources were positively related to sustainable mathematics learning. From the regression analysis, it was found that the teaching-learning practices, learning resources, and student motivation were significant predictors of sustainable mathematics learning. Qualitative results also showed that examination pressure, insufficient teaching materials, and traditional teaching pedagogies affected students' learning experience.

These results provide the basis for the development of a sustainable mathematics education model consisting of four inter woven dimensions, namely Pedagogical Empowerment, Affective Support, Contextual Resource Utilization, and Systemic Feedback Loops. Based on the results, the study suggests some shifts in pedagogical practices that are necessary to promote sustainable mathematics learning in the context of Nepal, which include shift from examining-centred and teacher-led approaches to learner centred approaches in mathematics teaching, continuous professional development of teachers, contextualization of resources, and change in assessment from summative to formative assessment practices.

Keywords: Assessment, feedback, Mathematics, motivation, Pedagogical, Sustainable.

INTRODUCTION

Mathematics is a key factor in fostering logical thinking, problem solving and critical thinking, which are essential skills to engage in the modern world. Educational systems around the globe increasingly focus on developing mathematical competencies that do not just apply to academic achievement in mathematics but are meant to be applied to education and life in general, in ways that foster a sustainable mathematical practice. Sustainable mathematics education goes beyond the achievement of short-term results in exams and aims for lasting understanding, positive attitudes, confidence and a lasting interest in mathematics (UNESCO, 2020). Skovsmose (2011) has classified four principles for sustainable mathematics education into: equitable, flexible, socially relevant, and supportive of the intellectual and emotional growth of the learner.

Mathematical education plays a key role in Nepal school curriculum. Conceptual understanding, problem solving and higher order thinking skills are highlighted in National Curriculum Framework (MoEST, 2019). However, all these policy goals are not fully realized in the classroom, where student-centered learning, procedural learning and exam-oriented learning continue to be predominant. This means that there is a significant difference between what is intended and what actually happens in lessons. Students often experience challenges

in developing their conceptual understanding and positive dispositions towards mathematics, which is a concern with sustainability of mathematics learning outcomes.

There are a number of contextual issues which further complicate mathematics education in Nepal. Our country's geographical inequalities add to the inequitable provision of education and learning opportunities. The limited availability of instructional materials, technology, and trained teachers in rural schools is in contrast with the greater availability of educational support in urban schools (Pant, 2017). Further, there are high demands on the students from society and parents to perform well in examinations, especially in the Secondary Education Examination (SEE), which encourages students to memorize and learn procedures rather than understand the material. These situations can negatively affect students' motivation and sustained interest in mathematics.

There has been an increasing number of publications that have identified mathematics anxiety as one of the main hurdles in the effective learning of mathematics. Boaler, (2016) and Bandura (1997) both reported that students' lack of confidence, motivation, achievement and willingness to undertake mathematical tasks are the negative effects of mathematics anxiety. Language issue (Nepali to English medium) (Luitel & Taylor, 2007) and examination pressure (Poudel & Poudel, 2020), lack in teacher professional development, lack of contextualized learning materials are all factors that have been linked to mathematics anxiety among students in the Nepali context. In addition, social pressures from parents, peers and communities can magnify psychological pressures, impacting the educational experiences and goals of students.

Various studies have investigated factors related to mathematics learning separately, such as students' mathematics anxiety, mathematics teaching methods, mathematics learning environment, mathematics assessment methods, and students' motivations. But, most studies have looked at these determinants separately. There is little research that has examined the interaction among the cognitive, affective, pedagogical and contextual factors and how its interaction affects the sustainability of mathematics learning, especially in secondary schools of Nepal. Hence, there is a need for an integrated approach that can explain the interconnectedness of these factors that impact sustainable mathematics teaching and learning.

This research is based on the concept of Sustainable Mathematics Learning from Sociocultural Theory (Vygotsky, 1978), Self-Efficacy Theory (Bandura, 1997) and Critical Mathematics Education (Skovsmose, 2011) and aims to fill this gap by investigating the factors influencing sustainable mathematics learning in the secondary schools of Nepal. The study aims to explore the relationships between mathematics anxiety, students' motivation and

confidence, teaching and learning practices, learning environments and resources, assessment and feedback practices and sustainable mathematics learning outcomes.

The study was guided by the following research questions:

- What are the key factors of sustainable mathematics learning in the secondary schools of Nepal?
- What are the students' and teachers' perceptions of the factors affecting mathematics teaching and learning?
- How are mathematics anxiety, student motivation, teaching-learning practices, learning resources, assessment practices and sustainable mathematics learning related to each other?
- What are the factors which significantly predict the sustainable mathematics learning in Nepal among secondary school students?
- What is the way forward for building an integrated model of sustainable mathematics teaching and learning in Nepal?

LITERATURE REVIEW

In mathematics learning, the focus is on the sustainability of learning that has a long-term emphasis that emphasizes that students' learning towards long-term conceptual learning, as well as confidence, problem solving, and the use of mathematical concepts beyond the scope of examination (UNESCO, 2020). The following sustainable mathematics education requires three conditions, namely, equity, re-contextualization, and support for cognitive and affective development (Skovsmose, 2011).

Mathematics anxiety is one of the factors that have been widely investigated in mathematics education. Students' mathematics anxiety hinders their motivation, confidence, achievement and involvement in mathematics-related activities (Bandura, 1997; Boaler, 2016). Mathematics anxiety can be attributed to some of the factors such as examination pressure, language transition, lack of appropriate teacher training programs, and lack of contextual learning materials in secondary schools in Nepal (Poudel & Poudel, 2020; Luitel & Taylor, 2007).

The learning outcomes in learning mathematics are also shaped by teaching-learning activities. In Nepalese classrooms, traditional teacher-centered approaches are still prevalent, and focus on memorization and procedural knowledge (Pant, 2017). Learner-centered and activity-based methods on the other hand foster conceptual understanding, participation, and

positive attitudes in learning mathematics. Likewise, the presence of instructional materials and supportive learning contexts is correlated with increased student involvement and success, and the lack of instructional materials and support, with less effective teaching and learning.

Another factor that is critical to mathematics learning is assessment practices. While high-stakes exams may promote memorization and promote anxiety in students, formative assessment and constructive evaluation will foster deeper learning, self-regulated learning, and long-term motivation. Modern education research thus calls for learning-focused assessment systems.

The present study is guided by three theory frameworks: Vygotsky's Sociocultural Theory (1978) that underscores the importance of learning through social interaction; Bandura's Self-Efficacy Theory (1997) which focuses on confidence and motivation in learning; and Skovsmose's Critical Mathematics Education (2011) that prioritizes the importance of meaningful and socially relevant learning.

Research on mathematics anxiety, teaching practices, learning resources and assessment systems have been conducted separately, although some past studies have focused on these areas. The synergy of these two in relation to sustainable learning of mathematics in the Nepal context has been a subject of limited research. To fill this gap, this study aims to explore the relationships among the four aspects (affective, pedagogical, contextual and assessment-related) and to introduce an integrated model for sustainable mathematics teaching and learning in Nepal.

Theoretical Framework

This study is based on the three theoretical approaches that are complementary and have provided a holistic understanding of sustainable mathematics learning: Vygotsky's Sociocultural Theory (1978), Bandura's Self-Efficacy Theory (1997), and Skovsmose's Critical Mathematics Education (2011). These theories are complementary in describing the significance of social interaction, beliefs held by learners, pedagogical practices, and contextual factors on students' long-term involvement and success in mathematics.

The Sociocultural Theory of Vygotsky focuses on the social nature of learning, which is influenced by teachers, peers, and the social context. Vygotsky (1978) posits that learners develop knowledge as a result of learning within the Zone of Proximal Development (ZPD) in the context of guided participation and social interactions. According to this study, the teaching-learning practices and the learning environment are considered as one of the mechanisms in which students can be said to have mathematical understanding. Understanding is fostered

through collaborative learning, interaction in the classroom and culturally relevant teaching materials.

Bandura's 'Self-Efficacy Theory' emphasizes that learners' self-efficacy expectations explain their motivation, struggle and achievement. Students who are more confident and motivated to learn are more likely to participate in learning activities and to achieve success with mathematics whereas students with mathematics anxiety may act as an emotional barrier to learning (Bandura, 1997). In this context, students' motivation, confidence and mathematics anxiety are important affective factors that affect sustainable learning of mathematics. Moreover, positive teaching methods and feedback can boost pupils' self-efficacy and improve their learning results.

In Skovsmose's Critical Mathematics Education, the focus of mathematics learning is no longer just on doing mathematics and succeeding in mathematics tests. The theory believes that mathematics education should be meaningful, socially relevant and should be linked to learners' everyday experience (Skovsmose, 2011). This view emphasizes the need for learner-centered teaching, developing learning materials based on students' context, and real life learning to help students apply their mathematical knowledge in actual life. It also serves as a reminder of the drawbacks of exam-driven systems designed around rote learning over conceptual learning.

These theoretical frameworks can be integrated together to offer a multidimensional perspective to sustainable mathematics learning. Vygotsky's theory brings in the social and cognitive part of learning, Bandura's theory brings in the affective part of learning through motivation, confidence, and anxiety and Skovsmose's theory brings in the contextual and critical part of learning through relevance, equity, and meaningful application of mathematics. These theories provide a framework for understanding the complex interaction between pedagogical practices, learning environments, assessment processes and affective factors, and how this interaction can impact sustainable mathematics learning.

Thus, this study defines sustainable mathematics learning as the result of interplay of factors namely mathematics anxiety, student motivation and confidence, teaching-learning practices, learning environment and instructional resources, and assessment and feedback practices. With this, the theoretical framework becomes the starting point to analyze the relationship between these variables, and to design a comprehensive model for sustainable mathematics teaching and learning in Nepal.

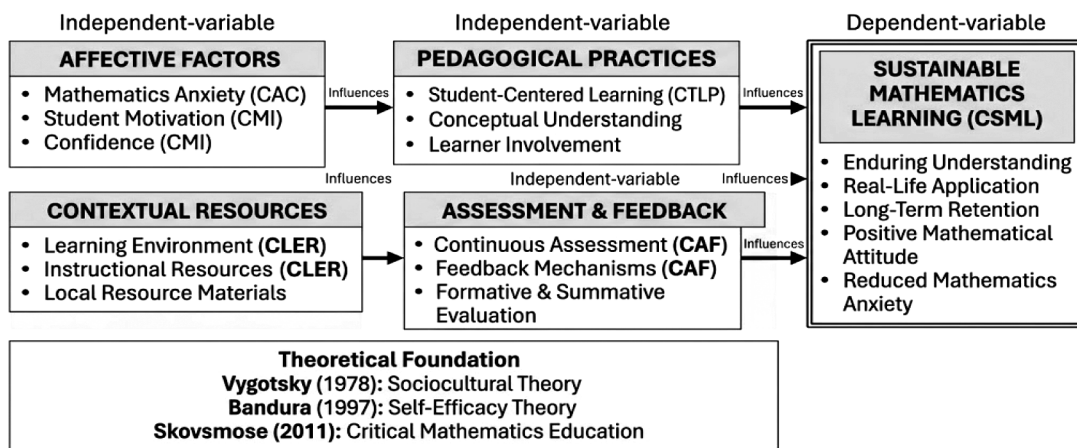
Conceptual Framework

The study is based on a theoretical framework of sustainable mathematics education, which is based on Vygotsky’s (1978) Sociocultural Theory, Bandura’s Self-Efficacy Theory (1997), and Skovsmose’s Critical Mathematics Education (2011). Overall, the perspectives highlight the significance of social interaction, learner self-confidence, meaningful interaction, and contextual relevance in mathematics learning.

The four factors highlighted in the framework (affective, pedagogical, and contextual and assessment) are considered to be interconnected, with the sustainable mathematics learning considered as the end-result of these. Affective factors are mathematics anxiety, student motivation and confidence. Pedagogical Practices: teaching approaches that encourage conceptual understanding and involvement of learners. Contextual resources include learning spaces and teaching resources that facilitate meaningful learning. Assessment practices: engaging in formative and summative evaluation processes that give feedback and inform learning. The dimensions are thought to affect sustainable mathematics learning, that is, students’ enduring understanding, application of mathematical knowledge, confidence, and attitude towards mathematics.

Figure 1

Conceptual Framework for Sustainable Mathematics Education



Note: Figer is generated by AI

Research Hypotheses

Based on the conceptual framework and review of literature, the following five hypotheses were formulated for the quantitative phase:

H1: Mathematics anxiety is significantly associated with students' motivation and confidence.

H2: Teaching–learning practices are significantly associated with sustainable mathematics learning.

H3: The learning environment and availability of instructional resources are significantly associated with sustainable mathematics learning.

H4: Assessment and feedback practices are significantly associated with sustainable mathematics learning.

H5: Teaching–learning practices, learning environment/resources, and student motivation jointly and significantly predict sustainable mathematics learning.

RESEARCH METHODS

This study used a mixed method convergent parallel design with simultaneous collection of quantitative and qualitative data, subsequent analysis of the data, and interpretation of the data. This design was chosen because it would be a good way to clearly convey both the statistics and participants' experiences and perceptions of factors that affect sustainable mathematics learning.

The study was carried out in three Secondary schools (one community school and two institutional schools) in Lekhnath area of Pokhara Metropolitan City, Kaski District, Nepal. School types were sampled stratifying to ensure representation. In the quantitative sample, a total of 102 Grade 9 students (aged 13-15 years) were included and 10 mathematics teachers and selected students were used for the qualitative sample. Prior to data collection, ethical approval and informed consent were sought from the school authorities, teachers, students, and the guardians of children.

The data-gathering instruments were quantitative and qualitative. A structured questionnaire with 26 Likert scale items (1 = Strongly Disagree to 5 = Strongly Agree) and one open-ended question was given for the quantitative phase. The instrument was validated by experts and pilot testing, and also satisfactory reliability (Cronbach's alpha = 0.814). Six constructs were measured in the questionnaire namely: student motivation and self-confidence, mathematics anxiety, teaching-learning practices, learning environment and instructional resources, assessment and feedback practices, and sustainable mathematics learning.

Open-ended questions, semi-structured interviews, focus group discussions, and classroom observations were used for the qualitative phase. Four teachers of mathematics took part in interviews and four focus groups of five students each were conducted to examine the

students’ perceptions of mathematics learning, anxiety, teaching practices, use of resources, and the sustainable learning. In three classrooms, observations in mathematics classrooms were carried out to triangulate the results from the surveys and interviews.

RESULTS

Data analysis for quantitative data was done using Statistical Package for the Social Sciences (SPSS) version 25. The data collected from 102 participants were used in descriptive statistical techniques as a way of summarizing the key constructs of the study.

Table 1

Descriptive Statistics

Variable	Mean	SD
CAC (Mathematics Anxiety)	3.85	0.73
CTLP (Teaching–Learning Practices)	4.23	0.48
CLER (Learning Environment & Resources)	3.48	0.63
CAF (Assessment & Feedback)	3.77	0.72
CSML (Sustainable Mathematics Learning)	3.77	0.65
CMI (Student Motivation & Confidence)	3.85	0.73

Note: N=102

The students’ general perception of classroom instructional practices was high as indicated by the highest mean score ($M = 4.23$, $SD = 0.48$) among the teaching–learning practices as reflected in Table 1. The mean scores of student motivation and student confidence ($M = 3.85$, $SD = 0.73$) and mathematics anxiety ($M = 3.85$, $SD = 0.73$) were also relatively high, which means that there is motivation and high level of confidence among students, while there was also the existence of mathematics anxiety.

The mathematical assessment and feedback practices ($M = 3.77$, $SD = 0.72$) and sustainable mathematics learning ($M = 3.77$, $SD = 0.65$) were moderately high, indicating a fairly positive perception of learning support and sustainable mathematics learning outcomes. By contrast, learning environment and instructional resources not only had the lowest mean score ($M = 3.48$, $SD = 0.63$), but it was also found to be a relatively less favorable area of mathematics education.

The results indicate that positive perceptions of teaching practice and motivation were reported by students, but some concerns that need to be addressed in order to foster sustainable learning in mathematics are mathematics anxiety and limited learning resources.

Table 2
Correlation between Primary Study Variables

	Correlations						Type
	CAC	CTLP	CLER	CAF	CSML	CMI	
CAC	1						
CTLP	0.472	1					
CLER	0.471	0.426	1				
CAF	0.526	0.452	0.608	1			
CSML	0.541	0.486	0.532	0.507	1		
CMI	1	0.472	0.471	0.526	0.541	1	
Type	0.322	0.234	0.213	0.39	0.281	0.322	1

Pearson correlation coefficients between the primary study variables are given in Table 2. The overall results indicate that most constructs are significantly positively correlated with one another, both pedagogical and learning-related, as well as contextual and affective. Teaching–learning practices (CTLP) and learning environment and resources (CLER) both had positive correlation with the sustainable mathematics learning (CSML), as did the students’ motivation and confidence (CMI), indicating that positive learning conditions are related to more positive learning results.

Of the contextual variables, the relationships between learning environment and resources and assessment and feedback ($r = .608, p < .001$) were strongest suggesting that supportive learning environments are likely to be correlated with more effective assessment practices. Sustainable mathematics learning was moderately associated with teaching–learning practices ($r = .486, p < .001$), learning environment and resources ($r = .532, p < .001$), and assessment and feedback ($r = .507, p < .001$), highlighting the importance of both pedagogical and contextual factors in promoting long-term mathematics learning.

There were small but statistically significant relationships between school type and several of the study variables indicating some differences between community and institutional schools. Gender, on the other hand, was not significantly related to any of the major constructs ($p > .05$), suggesting that perceptions of mathematics learning were quite similar across male and female students.

The results of the correlation analysis showed that the sustainable learning of mathematics is influenced by the instructional practices, learning resources, assessment process, and other factors related to students. The results of these findings are preliminary evidence for the integrated framework proposed in this study.

Table 3*Multiple Linear Regression Analysis Predicting Sustainable Mathematics Learning (CSML)*

Variable	B	SE	β	t	p	VIF
(Constant)	0.534	0.502		1.065	.290	
Motivation (CMI)	0.254	0.092	.284	2.771	.007	1.789
Learning Environment & Resources (CLER)	0.247	0.106	.237	2.334	.022	1.752
Teaching-Learning Practices (CTLP)	0.280	0.126	.204	2.225	.028	1.439
Assessment & Feedback (CAF)	0.124	0.101	.136	1.218	.226	2.135
Institution Type	0.072	0.112	.054	0.640	.524	1.215
Background	-0.089	0.100	-.082	-0.889	.376	1.440

A multiple linear regression analysis was then carried out to determine how well the teaching-learning practices (CTLP); learning environment and resources (CLER); assessment and feedback (CAF); student motivation (CMI); institution type and student background predict sustainable mathematics learning (CSML). As of yet, mathematics anxiety (CAC) has been removed from the final model as it contained perfect multicollinearity with motivation, so it does not have a unique predictive effect.

The regression model is statistically significant as revealed in the results (Table 3): $F(6, 95) = 12.556$, $p < .001$. Multiple correlation coefficient was $R = .660$, which means that the combined predictors of the model explain about 43.5% of the total variance in sustainable mathematics learning (Adjusted $R^2 = .412$). This validates the model's proposed reliability in predicting sustainable outcomes.

The statistical analysis of each coefficient showed that there were three positive predictors that could be considered statistically significant: student motivation ($p = .007$, $\beta = .284$); learning environment and resources ($p = .022$, $\beta = .237$); and teaching-learning practices ($p = .028$, $\beta = .204$). On the other hand, there was no unique and significant contribution of assessment and feedback practices, type of institution, and the student background to the variance of the model ($p > .05$).

The results of this study confirm, in an empirical way, that three elements, intrinsic motivation, supporting environmental resources, and effective learning practices, are the most crucial factors in mathematics learning that is sustainable.

Hypothesis Testing summary

The five hypotheses were tested empirically using SPSS Version 25 using Pearson correlation and multiple linear regression analyses as needed. The continuous constructs—such as mathematics anxiety, student motivation and confidence, teaching-learning practices, learning environment and resources, assessment and feedback practices, and sustainable mathematics learning—were measured using composite scores, based on Likert scales, given to the various constructs. All analyses were conducted at $\alpha = 0.05$ level of significance.

Correlational Results ($H_1 - H_4$)

The first four hypotheses explored the bivariate relationships between the constructs. The results confirmed that there was a perfect positive correlation between mathematics anxiety and students' motivation and confidence ($r = 1.00$, $p < .001$) for which Hypothesis 1 was supported. Also, the hypotheses of 2 and 3 were confirmed such that the sustainable mathematics learning had a moderate, positive, and statistically significant correlation with the effective teaching-learning ($r = 0.486$, $p < .001$) and the supportive learning environment with adequate resources ($r = 0.532$, $p < .001$). Lastly, Hypothesis 4 suggested that assessment and feedback practices are highly related to sustainable mathematics learning. This hypothesis is only partially supported by the correlation, which was significant and positive ($r = 0.507$, $p < .001$), as the subsequent regression analyses indicated that assessment and feedback are not the only variables that predict sustainable learning outcomes.

Predictive Modelling (H_5) and Interpretation.

Hypothesis 5 examined if the teaching-learning practices, learning environment/resources and student motivation could explain a shared variance in sustainable mathematics learning. This hypothesis was completely confirmed. The multiple regression model was statistically significant, $F(6, 95) = 12.556$, $p < .001$ and accounted for 43.5% of the variance in sustainable mathematics learning ($R^2 = 0.435$). In this model, student motivation ($\beta = 0.284$, $p = .007$), learning environment and resources ($\beta = 0.237$, $p = .022$), and teaching-learning practices ($\beta = 0.204$, $p = .028$) were significant positive predictors. Assessment practices, type of institution and background variables were not significant. Collinearity diagnostics showed no problems with multicollinearity (VIF range: 1.215–2.135). When taken together, these results support a multidimensional approach to sustainable mathematics learning, and they show that in this case, three factors pedagogy, physical resources, and intrinsic motivation of the learners—are the most important influences on long-term outcomes.

Table 4*Summary of Hypothesis Testing Results*

Hypothesis	Statistical Test	Key Result	Significance	Conclusion
H1: Mathematics anxiety is associated with motivation/confidence.	Pearson correlation	$r = 1.00$	$p < .001$	Supported
H2: Teaching–learning practices are associated with sustainable learning.	Pearson correlation	$r = 0.486$	$p < .001$	Supported
H3: Learning environment and resources influence sustainable learning.	Pearson correlation	$r = 0.532$	$p < .001$	Supported
H4: Assessment and feedback are associated with sustainable learning.	Pearson correlation	$r = 0.507$	$p < .001$	Partially supported
H5: Pedagogy, resources, and motivation jointly predict sustainable learning.	Multiple regression	$R^2 = 0.435$, $F = 12.556$	$p < .001$	Supported

The quantitative results show that the teaching learning practices, learning environment and resources, and students' learning motivation and confidence are significant factors which can predict sustainable mathematics learning. The relationship between mathematics anxiety and motivation and confidence was pronounced, but it seems that the effect of mathematics anxiety is indirect. In the same way, assessment and feedback practices were found to be positively related to sustainable mathematics learning, but this relationship was not found to be significant when other variables were controlled. The results are posted to a multi-faceted model where pedagogical, contextual and affective aspects all play a role in sustainable mathematics learning.

The qualitative analysis resulted in four main themes. The relationship between anxiety and high-stakes examinations was the first emphasized by the Anxiety–Examination Nexus. The first relationship that the Anxiety–Examination Nexus emphasized was between high-stakes examinations and anxiety. Second, Textbook Dependency exposed the scarcity of instructional materials, especially in the rural schools where textbooks are the most predominant learning tool. Third, Promising Sustainable Practices found that peer learning, contextualized teaching and learning, and locally developed teaching materials can be used to increase student engagement and lower anxiety. The concept of sustainable mathematics learning that

was developed by the participants was in the form of long-term conceptual understanding, application of mathematical knowledge, and trust in using mathematics in daily life.

DISCUSSION

The results of this research clearly indicate that there are a number of affective, pedagogical, contextual and assessment related factors that affect sustainable mathematics learning. Like past studies, mathematics anxiety was revealed as an important obstacle for students' motivation, confidence and involvement in learning mathematics (Bandura, 1997; Boaler, 2016). The qualitative results also indicated that the examination pressure, fear of failure, and teacher-centered instructional practices were factors that caused students' anxiety. The results of this research suggest that in addition to cognitive achievement, teachers should also look at students' emotion response in the classroom to achieve sustainable mathematics learning. The positive correlations found between the teaching-learning practices, learning resources, and sustainable learning of mathematics show that a learning-centered pedagogy is important. A greater sense of opportunity for students to participate, discuss, collaborate, and apply mathematics was also associated with students' perceptions of sustainable learning. The result is in line with Vygotsky's (1978) sociocultural theory, which is focused on the significance of social interaction and guided learning in knowledge construction. The findings are also consistent with the earlier research indicating that active-learning methods improve students' understanding, motivation, and retention of mathematics.

Based on the regression analysis, the teaching-learning practices, learning environment and learning resources, and student motivation and confidence were found to be the significant predictors of sustainable mathematics learning. The results indicate that as well as quality of instruction, supportive learning environments and students' self-efficacy are essential for effective mathematics education. The outcome is in line with Bandura (1997)'s Self-efficacy theory which suggested that confidence and motivation are factors that affect learners' persistence and achievement. When students feel that they are able to learn, they are more likely to have a positive response to the learning challenges and to continue to learn over time. The results also highlight the relevance of context in mathematics teaching. The principle sustainable mathematics education cannot be provided uniformly is evident in the differences in resources and opportunities for learning available across schools. Rather, approaches to instruction and resource use should be based on local contexts and learners' needs. This is in line with Critical Mathematics Education as described by Skovsmose (2011) which believes

that the learning of mathematics must be relevant to society, responsive to culture and related to real life. In general, the study adds to the existing body of research on sustainable mathematics education by showing that long-term mathematics learning is influenced by the interplay between affective, pedagogical, contextual and assessment-related aspects.

The results do not highlight each of these factors separately but rather indicate a need for an integrated perspective that would look at the problem of mathematics anxiety, as well as student motivation, teaching systems, mathematics resources, and assessment systems.

Proposed model for sustainable mathematics teaching and learning

This study proposes an integrated sustainable mathematics teaching and learning model with the quantitative and qualitative results. The focal point of the model is sustainable mathematics learning which is simply a long-term learning of the concept, meaning that the attitude towards mathematics is positive, confidence in mathematics becomes higher, and the ability to think, feel and apply mathematical knowledge in daily life becomes stronger.

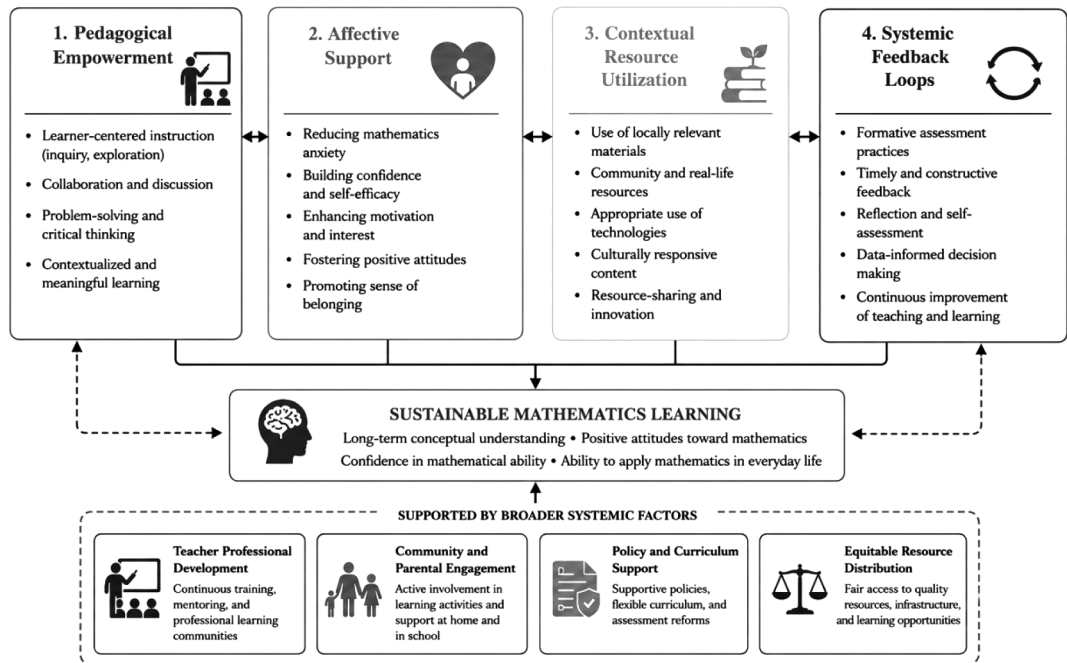
The model is made up of four interrelated dimensions. Pedagogical Empowerment focuses on learner-centered instructional strategies that encourage inquiry, collaboration, problem-solving and contextual learning, also, the first dimension. The second dimension Affective Support emphasizes mathematics anxiety reduction and increases the students' confidence, motivation and feeling of belonging in the learning environment. The third dimension, Contextual Resource Utilization, emphasizes the need to utilize locally relevant materials, community resources, and appropriate technologies to enhance the learning experiences. The fourth dimension, Systemic Feedback Loops, focuses on formative assessment and constructive feedback practices that encourage continuous improvement, rather than on the performance of high-stakes examinations.

These dimensions are underpinned by other systemic issues such as teacher professional learning, community and parental engagement, policy support and equitable resource allocation. These elements combine to make up a sustainable learning ecosystem that allows improvement in one aspect to support improvement in another. For example, good formative assessment can alleviate learners' pressure, enhance learners' self-confidence, and boost learning efficiency, which is a contribution to sustainable mathematics learning outcomes.

Thus, the proposed model offers a complete model to understand and reform mathematics education in Nepal. It provides practical suggestions for teachers, school leaders, curriculum developers, and policy makers who want to foster equitable, meaningful, and sustainable experiences of mathematics learning.

Figure 2

Proposed Model for Sustainable Mathematics Teaching & Learnings



Note. Solid arrows indicate direct influence; dashed arrows indicate reciprocal feedback.

Note: Figure is generator by AI

CONCLUSION

The aim of this study was to explore some of the factors affecting mathematics learning towards sustainability in Nepali secondary schools such as mathematics anxiety, student motivation and confidence, teaching-learning practices, learning environment and resources, and assessment and feedback practices.

The results reveal that sustainable mathematics learning is a multi-dimensional phenomenon that has been shaped by the interplay of affective, pedagogical, contextual and assessment-related factors.

The research points to the significance of learner centred teaching methods, an enabling and supportive learning environment, and the learners' motivation and confidence in sustaining learning in mathematics. The mathematics anxiety was identified as one of the major issues; however, pedagogical strategies, appropriate feedback and meaningful learning

experiences were identified that could limit the negative impact of mathematics anxiety. The results also show that it is not just the improvement of infrastructure or technology that will make sustainable mathematics learning possible, but also educational practices which take into account the cognitive and emotional aspects of learning.

This study makes an important contribution of an integrated model of sustainable mathematics teaching and learning, which integrates pedagogical empowerment, affective support, utilization of contextual resources, and systemic feedback mechanisms. The model helps to clarify the ways in which these interrelated dimensions help shape students' enduring mathematical understanding, confidence, and engagement.

The results are significant for the education practice and policy in Nepal. Through ongoing teacher professional development, teachers should be supported to use learner centered teaching, formative assessment, and strategies that help to reduce mathematics anxiety. Schools must promote the utilization of contextualized resources for learning and create contexts in the classroom which facilitate collaborative, investigative and positive learning experiences. In the policy arena, a stronger emphasis should be given to the need for balancing the demands of examinations with the use of formative assessment and competency-based assessment that foster meaningful learning.

The study is useful to provide inputs on sustainable mathematics learning but has been limited to a small number of schools and may not reflect all mathematics learning environments in Nepal. Further studies with larger and more diverse samples are recommended, a pattern of mathematics learning over time should be investigated, as is the need to validate the proposed model in additional educational contexts. Finally, a combination of effective pedagogy, a supportive learning environment, positive learner dispositions and responsive assessment practices are needed for sustainable mathematics learning to occur. Incorporating these interrelated aspects in the mathematics education could help transform the way mathematics is taught in Nepal from examinations-centred learning to more meaningful, equitable and sustainable learning experiences.

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