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Feedback to Rectify Learning Crisis in Mathematics: A Classroom-Based Action Research among School Students

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Feedback, learning crisis, anxiety, motivation

Abstract

The learning crisis in mathematics is deepening in the context of Nepal. Studies showed that the motivation and engagement of students in learning are decreasing. So, this study was designed to explore the role of feedback in rectifying the mathematics learning crisis. To achieve the objective, classroom-based action research was designed. This action research was conducted in the school located in the Kathmandu district. Five students and their parents were selected as respondents. Interview schedules, observation notes and focus group discussions were used to collect the information and analyze using the thematic analysis method. The result of the study shows feedback strategies such as developing positive learning emotions, providing exemplar assignments, written and oral comments and suggestions, using dialogue and discussion methods in classroom instruction, and providing opportunities for self and peer assessment help to minimize the anxiety of learning mathematics, reduce social media addiction and increase motivation in learning mathematics.

Introduction

Context

I have been teaching mathematics from school to university level for more than 15 years. In the long span of my teaching career, I have been experiencing that the learning habits of students in mathematics are decreasing. Today students' priority seems to be getting good grades rather than engaging in quality learning. To get good grades, students need to understand the subject matter well, but our students focus only on the pattern of questions in the final test and prepare them. The overemphasized value given grades and the format of exam questions have increased academic dishonesty (Ghimire et al., 2024). Similar to the findings of the review paper authored by French et al.(2024) the most focused closed book, time-constrained, summative types high-stakes examination system in Nepal is contributing to increased stress and examination anxiety in students

and reduced motivation and concentration in learning. It is found that there is declining interest in pursuing higher study in Nepal and a large number of students could not get threshold marks in the entrance exam for higher study after completion of school education (Pandey et al., 2023) and those who are studying at a higher level do not even have basic mathematical knowledge.

Deepening Learning Crisis in Mathematics

The learning crisis (deficit in learning) is deepening these days. The learning crisis is a global phenomenon, the reports of UNESCO (2013) and World Bank (2018) indicate more than 60% of children who completed primary education in low and middle-income countries fail to achieve the minimum competencies in reading and math. Programme for International Student Assessment for Development (PISA-D) study among developing countries shows that 80% of children do not have minimum levels of learning (Pritchett & Viarengo, 2023). The majority of students are progressing in their schooling without acquiring critical foundational skills such as literacy, numeracy, digital competencies, and problem-solving skills (Pritchett & Viarengo, 2023). In the context of Nepal, the Education Review Office's report published in 2022 showed that the mastery of learning in all subjects is less than 50% among eighth-grade students all over the country. In mathematics, 67.9% of students have achieved below the basic proficiency level. This result shows an alarming gap between the achieved and intended curriculum goals (ERO, 2022).

I also have similar experiences as mentioned in the literature. Students of grade XII make errors in basic fundamental operations (addition, subtraction, multiplication, and division), simplification, variables and constants, factorization, etc. For instance, I had asked students to solve linear programming problems using simplex methods. For that row operation is required. However, while observing the test paper of the students I found maximum errors in fundamental operations. Students use a calculator for simple addition and multiplication. While doing derivatives of the functions, students make mistakes in variables, constants, and coefficients. For example: students write the derivative of the function $x^2 - 5 = 0$ is $2x$ but $x^2 - a^2 = 0$ is $2x - 2a$. These are only sample pieces of evidence. The deteriorating level of students' learning performance forced me to search for some pedagogical solutions that could help to improve the learning habits of students and hence make better performance.

Feedback Intervention to Promote Learning Engagement and Performance in Mathematics

Feedback has been considered an effective tool for promoting students' learning (Hattie & Timperley, 2007; Shute, 2008) however, only effective feedback could work positively as pointed out by Scheeler et al. (2004). An interesting phenomenon was seen in the surveys that students experience feedback as one of the most common problems whereas teachers believe their feedback is more useful for learners (Shute, 2008). This indicates the mismatch between the feedback providers and receivers could be problematic. So, feedback should not be taken as the controlling mechanism of students' behaviors rather it should focus on transforming themselves through self-reflective and metacognitive practices. Studies suggest that corrective feedback is more effective (Goodman et al., 2008; Scheeler et al., 2011) than persuasive feedback. Regarding learning theories, cognitivism suggests both positive and negative feedback (Baker & Bricker, 2010) based on the context whereas behaviourism, social-cultural theory and

social constructivism argue feedback should be positive (Martens et al., 2010; Orsmond & Merry, 2011; Rodriguez et al., 2009; Scheeler et al., 2011). To sum, all the literature has suggested that feedback should be accurate and irrefutable, relevant and meaningful, and should balance positive and negative remarks.

Effective feedback mechanisms are crucial to enhance the engagement of learners in the learning process. The integration of different types of feedback can support to promote student behavioural, affective and cognitive engagement (Zhang & Hyland, 2022). If a teacher can provide feedback understanding the learners' emotional signals, then this type of adaptive feedback could improve learning effectiveness, reduce anxieties and enhance self-directed learning (Liu et al., 2022). Moreover, interactive feedback (Barana et al., 2021), productive dialogue in the classroom (Webb et al., 2019) and feedback on home assignments (Cunha et al., 2019) could increase the engagement of students in learning mathematics.

Thus, this study is focused on exploring how the feedback strategies applied by mathematics teacher could help to enhance engagement and support to reduce the learning crisis in mathematics. This paper is based on the findings drawn from action research where I have explored only how small changes can make a big difference in student's learning habits through the use of feedback [oral and written]. This finding would be useful to minimize the gap between student's expected and achieved learning outcomes in mathematics.

Methods and Procedures

This study used a classroom action research design. Action research is a practitioner's research that aims to improve existing situations (Best & Kahn, 2014). Action research brings together action and reflection, as well as theory and practice, in participation with others, in the pursuit of practical solutions to the issues of pressing concern. Action research not only explores the problems but also gives the pertinent solutions as well (Cohen et al., 2018). In this action research, I have explored the causes of demotivation in learning mathematics and how effective feedback mechanisms could be used to minimize the learning crisis in students.

For this study, the study site was an institutional school located in the Kathmandu district. Since this is classroom-based action research , I chose the school where I was working as a mathematics teacher during the time of research. The research was done in the academic year 2021/22 on grade XII science stream. The feedback intervention was similar to all students in the selected classroom. But, due to my time and other limitations, I chose only five students and their parents as respondents. At first, I received the documents of students from the administration, checked the Secondary Education Examination (SEE) results and marked the students who achieved at least an 'A' grade (more than 80% marks) in mathematics, after I compared the result of these students with the grade XII first terminal marks in mathematics. Among them, I chose five students who received an 'A' grade in SEE but failed to obtain the pass marks in grade XII's first terminal examination. Among five students, three of them were girls.

Data for this study was collected in three stages. In the first stage, I took individual interviews and conducted a focus group discussion (FGD) with selected five students regarding mathematics study habits, activities at home, motivation in learning

mathematics, and difficulties in learning mathematics. This process took me ten days to unearth the real facts about their learning habits. During the one-month intervention period, I taught derivatives, applications of derivatives and differential equation contents. I closely observed student's activities and took observation notes. After a one-month intervention, I took an interview with students and their parents (only three parents were available on the result day) and conducted an FGD with these five students.

Intervention Plan and Procedure

The feedback intervention was designed to promote a positive learning environment, provide support in learning mathematics, create a collaborative mathematics classroom through dialogue and discussion, provide corrective feedback, develop a positive mathematics learning attitude in students and encourage students to self-directed learning which is crucial to motivate students in learning (Liu et al., 2018; Liu et al., 2022; Malecka et al., 2022).

Figure 1 presents the intervention plan applied for this classroom-based action research. In the pre-intervention phase, I interviewed and discussed with the selected students and explored the problems regarding the motivation in learning, which factors are contributing to learning motivation and what are the common and distinct attributes among the students regarding learning habits, and attitudes. Based on the data, literature and learning situation, I prepared a feedback intervention plan to intervene inside and beyond the classroom.

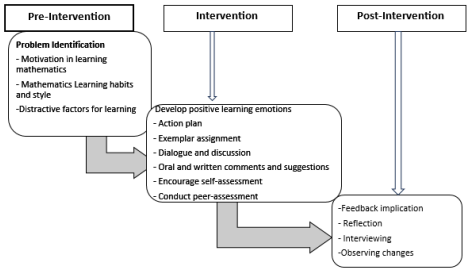
Increasing positive learning emotions in the students was the main focus of this action research. For that, I planned some intervention strategies to motivate students to learn mathematics and develop a mathematics-learning attitude. Firstly, I encouraged and collaborated with the students to make personalized plans outlining steps that students should take to improve their performance, i.e. study schedule; using smartphones, social media, and hangouts time; and mathematics learning strategies. The action plan contains some strategies for using smartphones for learning. For instance, searching and sharing mathematics content on social media, and useful websites for learning mathematics. This action plan could encourage self-regulation, and manage time for learning, leading to improved performance and motivation in learning mathematics. Secondly, I encouraged students to complete the tasks by providing exemplary assignments. For that sample examples were shared. For instance, in the chapter Tangent and Normal, the solution of the problem to find the equation of tangent and normal to the $f(x)= 2x^3-5x^2+8$ at (2, 4) was provided, annotated the main points such as derivative calculation, slope evaluation, use the formula to find the tangent and normal line, and geometrical meaning, so that, students could understand the concept and process and apply this on their work. Since, dialogue and discussion are important approaches to feedback to motivate students in learning (Webb, 2009; Webb et al., 2019). So, interactive discussions with the students in the whole class were conducted. These discussions could build close relations with teachers and enhance engagement, clarify misunderstandings, and create a supportive and collaborative environment in the classroom as argued by Hunter and Hunter (2018) and Webb (2009).

Fourthly, oral and written feedback were provided focusing on both strengths and areas for improvement. Immediate oral feedback in the classroom and detailed and actionable written feedback in homework/

classwork/assignment/ and or in the test paper were provided (Grawemeyer et al., 2017). These comments, feedback, and suggestions could help students to reflect on their learning process, and progress and guide further learning. Lastly, encourage students to evaluate their work, process and progress and allow peers to comment on other's works. For instance, students used to mark their unit test papers (tests that were taken after the completion of each chapter), made pairs, exchanged their papers within the pairs and provided feedback to each other. This could help to develop critical thinking skills and motivate them to learn mathematics. Also, fosters a collaborative learning environment and builds a community of learners (Liu et al., 2022; Malecka & Boud, 2021).

Figure 1

Single Cycle Action Research Plan



In the post-intervention phase, I interviewed students and their parents and conducted an FGD regarding the changes they realized after my one-month intervention.

The data obtained from the three sources daily observation diary (writing memo), interview and FGD were analyzed by using a thematic approach. At first, I screened the recorded and narrated text based on my research question and extracted the core text that is relevant to the research, after I developed the thematic headings based on the data for outcome analysis and described the themes connecting the verbatim of the participants and related literature (Thomas, 2006). To maintain the credibility of the results I triangulated the data obtained from interview, FGD and observation. Consent was taken from the students and their parents for participation in the study. The participation was completely voluntary and approval was taken from the administration for the research procedures. The privacy of the respondents is maintained in the study.

Results and Discussion

This chapter presents the results analyzed from the data obtained from different sources. The result obtained from observation, interview and FGD is presented in three thematic headings: From addiction to learning: smartphone reimagined, transforming math anxiety into motivation through feedback and enhancing mathematics learning habits through feedback.

From Addiction to Learning: Smartphone Reimagined

Smartphone addiction, known as nomophobia (no mobile phone phobia) refers to excessive use of smartphones and tablets and has been becoming increasingly prevalent among teenagers (Argumosa-Villar et al., 2017). During the interview, students shared that they could not spend a single night without a mobile phone and Internet. In an interview, I requested students to drop their smartphones at school for a week. One student replied, *"I can do fasting (stay without eating anything throughout the day) but I cannot spend even a single night without a mobile".* This statement of student indicates how students are addicted to the digital device. In pre-intervention FGD, it was found that students were wasting more than 60% (6-7 hours) of their time on other activities instead of studying. One student shared her routine, *"I return to my home from college at 1 PM, have*

lunch and sleep for about 1-1.5 hours. After waking up, I spend 1-2 hours on my phone or go out to meet friends and shop. Then, I do my homework, particularly updating my practical files in Physics and Chemistry. If there is homework in mathematics, I do it; otherwise, I skip studying mathematics. In the evening, I continue to do the homework and have dinner between 7:30 and 8 PM. I do my homework after dinner also but I use my mobile simultaneously because generally, we are in group chats at that time. After completing the homework, I use my phone mainly to surf Facebook and TikTok, chat with friends and watch videos. I usually go to sleep around 11 PM." This response indicates that students hardly manage their time for mathematics. Students do not have scheduled time to study. If students have homework assignments in mathematics, they would do otherwise students would not open the mathematics book at home. Mostly, the focus of the students was on using smartphones rather than on learning. Surprisingly, none of the students have a study routine at home. From the discussion and interview with students, as mentioned in different literature it can be concluded that Social media is the major distracting factor in learning (Dontre, 2021; Koessmeier & Büttner, 2021). The priority of students was in using media rather than in learning.

Social media like Facebook, Messenger, TikTok, Instagram, etc. are considered as major distracting factors for learning however these can be used to support learning (Fatimah, 2024). However, students have been using social media for entertainment rather than learning. To combat this problem, I collaborated with students and suggested making their action plans themselves. I suggested to all the students to make an action plan but followed up with the five students in particular. In the action plan, they included time for studying mathematics and other subjects, time for using social media and other activities. I suggested students segregate study time and smartphone time. To minimize the wastage of time on non-beneficial videos, pages, and news on social media I suggested students follow and share learning sites that help learn mathematics. Besides that, I also shared the pages with the students so that they could watch and learn something. I assigned students to share some content that they watched on social media. This activity motivated students to follow the learning sites rather than the entertaining sites. I also requested parents to monitor their children's activities.

After one month, I noticed changes in the student's activities. In the interview after intervention regarding the use of social media, one student shared, "*My Facebook has been changed now. In the past, irrelevant posts popped up on my Facebook page but now most of the content in my feed is related to learning including mathematics problems, solutions and video lessons. Even on TikTok, I have discovered mathematics content. I didn't realize that TikTok could offer educational material. In addition to mathematics, I can find content related to Physics, Chemistry, and Computer Science. It is exciting to be able to learn from social media platforms as well. The strategies of using social media as a learning resource helped to change the way of using social media*." Another student replied, *"When I separated study time and mobile time, I can allocate plenty of time for studying. I believe that if we manage our time properly, we have enough time for everything we need to do."* These two verbatims of the students indicate that the use of smartphones and social media does not always affect them negatively. Students realized that social media is helpful for lifelong learning as mentioned

in the literature (Chen et al., 2023; Kind & Evans, 2016).

Transforming Math Anxiety into Motivation through Feedback

Anxiety and motivation are negatively correlated attributes. The meta-analysis report of Li et al. (2021) shows that student's motivation for learning mathematics, competence beliefs and mathematics anxiety are negatively correlated. Some level of anxiety about learning mathematics is seen in all students and this could be a common issue in all contexts (Dowker et al., 2016) but the increasing levels of anxiety may cause demotivation, depression and dropout from study (Li et al., 2021). In this study, I observed two types of anxiety in students. A student who is conscious of his/her learning has anxiety because he/she is not performing in mathematics as expected and the other student who is demotivated in learning has anxiety because of teachers' and parents' pressure.

In the pre-intervention period, I explored the lack of motivation in learning mathematics. In FGD, students argued, *"Why do we need to get good grades sir if we are planning to go abroad after grade 12?"* In the interview, one student shared, *"When I start studying mathematics, different thoughts come to mind: What is the purpose of this content? Why am I taking this course? How will mathematics be useful in my future? These questions distract me, and I end up my study and start to use phone."* These few representative excerpts of students indicate that students had demotivation in learning mathematics.

To minimize anxiety and demotivation in learning mathematics, I focused on oral and written feedback, promoted dialogue and discussion with students and provided need-based individual support in learning. During the intervention, I discussed and shared examples of where mathematics is applied. For instance, while teaching differential equations I presented examples from economics, chemistry and physics where the derivative and integration were used. I also presented some real-life problems that can be solved using differential equations. I shared YouTube videos related to the application of derivatives in real life and further study. Besides these, I provided corrective feedback on classwork, homework and assignments, encouraged students to ask questions and present possible solutions in the classroom, etc.

After the one-month feedback intervention, I found students were becoming positive regarding learning mathematics. I observed that students started to ask questions in the classroom, participated in group discussions, submitted classwork and homework and expected feedback, etc. I also asked the students regarding their motivation in learning mathematics. One student shared, *"I have started to search and watch video lessons related to our content in YouTube. There, I found several video tutorials that are related to my content. If I cannot understand concepts in the classroom now, I can learn from YouTube."* This indicates that feedback is working to motivate students to learn mathematics. As argued by Malecka et al. (2022), it is essential to develop positive attitudes toward learning mathematics then the students themselves start to learn mathematics.

The oral feedback during the discussion in the classroom and written feedback after the homework, assignments and tests played crucial roles in reducing anxiety and enhancing motivation in learning. During the FGD, I asked students, *"Are you enjoying*

mathematics class?" They replied in one voice, *"Yes Sir!"* and one student among the five added, *"Mathematics classes these days feel similar to Nepali and English classes, where we engage in discussing and debating the problems of mathematics and solutions. I believe that if we take something difficult at the beginning then it will become more difficult, but if we take easy then it will become easier in the future. These days, I believe that mathematics is easier than Physics and Chemistry, and I am hopeful about achieving a good grade in my final exam."* Similar to the student's view, I also observed that students were more interactive and collaborative in the classroom. I experienced that students mostly expected positive feedback. So, in the discussion, I only talked about student's positive aspects. This kind of feedback strategy helped to increase the interactivity in the classroom. But, after one week of intervention, I started to provide some corrective feedback on the homework copy and met students individually regarding their learning process. Then, students' feedback acceptance rate was increased as argued by Baker and Bricker (2010). In the interview, I asked, *"How do you feel about the feedback provided in the note copy?"* One student responded, *"In the copy, I made several mistakes and you correct or give hints but at last, you mention like you are doing well, try to do additional questions related to the chapter, better to cover more problems, etc. This kind of comment motivates me to do extra problems from other resources"*. Students generally expected positive feedback as suggested by socio-cultural learning theories (Martens et al., 2010; Orsmond & Merry, 2011; Rodriguez et al., 2009; Scheeler et al., 2011). Thus, we should focus on providing positive feedback and encouraging students to learn mathematics.

Enhancing Mathematics Learning Habits through Feedback

In the interview and group discussion before the intervention, it was found that students give less priority to learning mathematics compared to other subjects like Physics and Chemistry. Due to the lack of study plan, negative learning attitude and other distracting factors mathematics learning habits of students were deteriorating. One student during the interview shared, *"We need to prepare practical files of Physics and Chemistry. Physics teachers give many numerical problems that take a long time. So, I cannot give sufficient time for mathematics."* Another student said, *"I attempted to solve the math problems from the book's exercise assigned as homework, but I couldn't solve them correctly, so I stopped. However, when a problem is solved, I enjoy doing more problems."* These verbatims indicate that students did not clearly understand the role of mathematics. So, they give less priority to learning mathematics. To enhance the mathematics learning habits of students I designed the feedback intervention which includes exemplar assignments, providing corrective written feedback on the assignment, and providing a chance for self and peer assessment.

After a few days of intervention, I observed that the homework completion rate increased. More than 80% of the students in the classroom followed exemplar assignments to complete the given assignments. Classrooms have become more interactive than in the past. At the last of the intervention, I interviewed the students and their parents regarding their changing habits in learning mathematics. One student said, *"The examples provided before the homework assignments supported me to complete the assignments. You explained every step of the solutions, discussed possible cases, visualized the solution through geometrical*

interpretation, and provided hints to solve the remaining problems helped me to complete the assignment." This view of student indicates that the model example or exemplar assignment provided in the classroom before the assignment could support students to complete the given tasks. So, we should make the mathematics learning process more simple, flexible and collaborative rather than presenting mathematics as a difficult subject to support those students who feel mathematics a difficult and isolated subject (Mathias et al., 2024).

Feedback intervention was also focused on promoting the engagement of students in learning mathematics. I interviewed the parents of selected students regarding their children's learning habits at home. One parent replied, *"In these days, my daughter is starting to study. She is also doing better in mathematics than in previous tests. I think, her confidence in doing mathematics is also increasing. I appreciate your effort to make this change."* In a similar way, another parent replied, "*I have experienced that my son has been focusing on learning rather than using mobile. In the past, he always seemed busy in mobile games but now he is starting to learn."* Not only parents their children also reported similar views regarding mathematics learning habits. One student said, *"These days, first I complete the given mathematics homework or assignment, only after that I do Physics, Chemistry, etc. subjects."*

The provision of self and peer evaluation of the work done by the students has also played a positive role in enhancing learning habits. In particular, after the tests, I used to distribute the test paper and ask them to mark themselves, share their copies with their pairs and discuss solved and unsolved problems. In particular, self-evaluation could help to realize the student's position and correct their mistakes. One student expressed a similar view, *"The process of self-marking in the answer copy, discussing with pairs and reporting to the teacher made me more serious about learning mathematics. I realized my mistakes and tried to resolve them."*

The views of parents, students and my observation showed that the feedback could help in cognitive, affective and behavioural engagement in learning as argued by Zhang and Hyland (2022). The feedback mechanism helped to enhance mathematics learning habits and reduce math anxiety (Liu et al., 2022). As argued by Cunha et al. (2019) the written feedback given in homework and assignments also helped to increase the engagement in learning mathematics.

Conclusion

The result shows that different feedback strategies like developing positive learning emotions, exemplar assignment, planning, dialogue and discussion, oral and written comments and suggestions, and self and peer assessments can develop positive learning attitudes, improve learning habits, reduce social media addiction, and minimize the anxiety of learning mathematics. The intervention was very simple so that every mathematics teacher in each class could apply. During this research, I faced some challenges in applying all the strategies planned in the intervention like overloaded content, pressure to complete the course within the given time frame, exam-oriented teaching and learning environment and fixed mindset of authorities. This classroom-based action research was conducted over one month, and while it may not meet all the standards of action research,

it undoubtedly opens the way for further research in this field.

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