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Exploring Flipped Learning Environment and Practices in Secondary Mathematics Classrooms in Nepal

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Abstract

The flipped learning approach (FLA), a technology-driven, active pedagogical model, has been widely researched and adopted globally across all academic levels and disciplines to enhance educational quality. However, in the context of Nepal, there appears to be a notable lack of studies on FLA. This micro-ethnographic study examined the flipped learning environment and practices in Grade 10 mathematics classrooms in Nepal. One school, a mathematics teacher, and three students were purposively selected as participants. Qualitative analysis of data collected through direct observation and in-depth interviews revealed an inadequate environment for adopting FLA, with challenges related to teachers, students, technology, and the school's support. The study investigated constructivist, inquiry-based, and problem-solving in-class practices, involving active discussions, interactions, group work, completing exercises, and guided problem-solving, that closely aligned with FLA. However, out-class practices were constrained to solving exercises and practicing old question sets due to the deficiency of teachers' lecture videos. This study suggests that stakeholders in mathematics education should take responsibility to create favorable FL environments for its effective adoption and promote meaningful learning in mathematics.

Keywords : Flipped learning approach (FLA), flipped learning (FL), practices, mathematics classrooms (MCs), effective learning, student-centered

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Introduction

Flipped Learning Approach (FLA) is a technology-based, student-centered, and innovative instructional method that has evolved with the advancements in digital technology since the 1990s (Cevikbas & Kaiser, 2020; Patterson et al., 2018). After Bergmann and Sams's successful implementation in an American high school in 2007, FLA gained global recognition among educators and researchers (Ahmed, 2016). Since 2012, its global adoption has been meant to provide quality education (Lee, 2023), and it is considered a significant pedagogical innovation within school education (Horn, 2013).

The fundamental FLA concept is that it provides individualized pre-class basic learning through online lecture videos and supplementary materials, followed by in-depth learning through collaborative and interactive learning activities in the classrooms (Bishop & Verleger, 2013; Lo & Hew, 2017). In this context, Lage, Platt, and Treglia (2000) define FL as a process where "events that have traditionally taken place inside the classroom now take place outside the classroom and vice versa" (p. 32). Likewise, Bergmann and Sams (2012) express FLA as an instructional method, "where work that was traditionally done in the class is now done at home, and what was traditionally homework is now completed in the class" (p. 13). These early definitions highlight the inversion of instructional spaces, time and activities in relation to traditional teaching. However, the Flipped Learning Network (FLN) (2014) provides a broader concept, asserting that flipped learning shifts direct instruction from group learning space to the individual learning space via technology and the resulting group space is turned into a dynamic, interactive learning environment where learners are frequently guided and supported by the educator while engaging in content matters.

The FLA's dynamic classroom activities primarily involve discussions, interactions, problem-solving tasks, question–answer sessions, presentations, and collaborative work. These activities are supported by the teacher's continuous monitoring, guidance and feedback, which ultimately improves students' motivation, engagement, self-regulation, including content comprehension, higher-order abilities, and academic performance (Abeysekera & Dawson, 2015; Cheng et al., 2019; Muir & Geiger, 2016; Schmidt & Ralph, 2016). Therefore, FLA seems to be a learner-centered, innovative, and effective instructional model, currently gaining extensive popularity in the field of teaching and learning.

With the rising popularity and widespread adoption of FLA, research trends on the flipped model have gained momentum across the educational levels and disciplines (Brigili et al., 2021; Lee, 2023). As a result, scholars have investigated its effective frameworks, design principles, instructional practices, and pedagogical impacts (Brigili et al., 2021). In this regard, the FLN, (2014) forwarded the four-pillar FLIP framework, consisting of: Flexible Environment (F), which indicates its flexibility to learn contents by the students at their own pace, place, and style with regular feedback and support from teachers and peers; Learning Culture (L), that focuses on student-centric learning environment where learners become active constructor of their knowledge and educators act as facilitators and evaluators; Intentional Content (I), emphasizes on teachers' decision about materials for pre-class delivery based on learners' needs; and Professional Educator (P), that underscores educator's roles in designing and applying effective learning activities, monitoring student progress, and providing proper feedback (Hamden et al., 2013; Patterson et al., 2018). Regarding the FLIP framework, Muir and Geiger (2016) viewed it as a significant foundation for understanding FLA's strategies and evaluating its implementation, particularly in terms of learning environment, pedagogical practices, and educators' roles. Therefore, the FLIP framework serves as a lens to study the FL environment and its practices.

In order to ensure effective implementation of the FL model, it needs to be well-structured by following specific design principles. Highlighting the implementation design of FLA, Kim et al. (2014) have recommended nine principles: provide online lecture videos to the learners for basic learning before class; encourage them to watch the videos and be ready for in-class activities; manage assessment methods; link in-class and out-class activities; give proper guidance and enough time to complete assignments; encourage learners to build learning groups; provide immediate feedback; and use favorable technology. These principles seem essential for practitioners to move into FLA with effective design and practice.

The flipped pedagogy, compared to conventional lecture methods, has been found to create more positive impacts on students' learning outcomes while fostering their higher abilities, social and digital competencies. Specifically, FLA's flexible, individualized, collaborative, and active learning opportunities, including extra in-class time and instructors' regular guidance, foster students' motivation, engagement, creativity, competence, understanding, and academic performance (Bergmann & Sams, 2012, 2014; Lo et al., 2017; Park & Kim, 2022; Wei et al., 2020). Conversely, some studies have revealed low positive or no effect of the approach on students' performance relative to traditional methods (e.g., Clark, 2015; Kirvan et al., 2015; Lai & Hwang, 2016). Such a contrasting finding might be caused by the employed flexible design, framework, implementation and evaluation strategies, and the nature of courses (Fung et al., 2021; Kostaras, 2017). Nevertheless, using appropriate design, frameworks, instructional activities and effective evaluation methods, FLA can be conducive to enhancing students' achievement across diverse disciplines, including mathematics.

Compared to other subjects, students generally find mathematics difficult to learn due to its abstract and symbolic nature (Gafoor & Sarabi, 2015). Therefore, for comprehensive learning, organized reasoning, and achieving better results in mathematics, learners require enough effort, meaningful discussions, interactions, active engagement, and the teacher's proper guidance and feedback (Gafoor & Sarabi, 2015; Vygotsky, 1978, 1987). In this sense, FLA appears to be a relevant model for effectively teaching and learning mathematics. In this regard, Cevikbas and Kaiser (2020), Ford (2015), Ichinose and Clinkenbeard (2016), and McBride (2015) underscore the FLA's potential to create meaningful mathematics learning by facilitating active engagement, interactions, feedback and scaffolding for students. Likewise, Lo et al. (2017) indicated FLA's in-person feedback, extra class-time and peer-learning as key factors for resulting positive impacts in mathematical learning. Additionally, Patterson et al. (2018) claimed that, even without using technology, FL practices emphasizing group-based active learning and graded reading had raised students' motivation, engagement, and achievement in mathematics compared to lecture methods. Furthermore, Fung et al. (2021) proposed a three-stage FL framework, comprising: pre-class materials, short in-class revisions, and interactive activities such as discussions, group work and problem-solving with the teacher's feedback for meaningful learning and improving students' results in mathematics. Thus, FLA emerges as a significant instructional approach for fostering meaningful and effective learning in mathematics.

In Nepal, mathematics is valued as a significant core subject in school curricula. Up to Grade 10, it is one of the compulsory subjects, while from Grade 9 – 12, additional mathematics is also included as an optional subject. However, the situation of mathematics education is challenging at this level. It is often perceived as a difficult subject suitable only for gifted learners (Belbase, 2013; Lamichhane & Belbase, 2017). According to Khanal (2011) and Belbase (2013), such a negative perception has developed due to the continued practice of traditional teaching methods and high failure rates in mathematics. Moreover, school students are struggling to comprehend, analyze, and generalize mathematical concepts (Pokhrel et al., 2024). Such a situation might be raised by the preferred rote learning pedagogical practices instead of emphasizing practical learning in mathematics. Likewise, Acharya et al. (2022) also indicated dominant practice of lecture methods in mathematics classrooms (MCs), which have limited the students' motivation, engagement and higher-order abilities, including their performance in the subject. Regarding the academic results, Education Review Office (ERO) (2021) reported that a majority of Grade 10 students showed poor results in mathematics, with 59% under the basic proficiency level.

To enhance the poor performance of Grade 10 students, the ERO (2021) has suggested adopting student-centered, active learning strategies in MCs. At the same time, the key education policy documents, including the National Education Policy (NEP) (2019), the National Curriculum Framework (NCF) (2019), and the School Sector Development Plan (SSDP) (2016–2023), have emphasized student-friendly, technologyintegrated pedagogical strategies to impart quality education and develop students with 21st-century skills. In this scenario, the FLA, as a student-centered and technology-driven instructional model, can be an appropriate pedagogical method to address the policy preferences, above mentioned challenges, as well as to foster meaningful learning in school mathematics. However, in the context of Nepal, specifically, in Far West region, existing literature shows a notable lack of FL studies on FLA's implementation situation, practices and consequences in school mathematics context. Motivated by this research gap and my extensive experience as a secondary-level mathematics teacher with a profound interest in innovative pedagogical practices, this study aims to examine the flipped learning environment and investigate existing in- and out-class pedagogical practices in terms of FLA in Grade 10 MCs. To achieve the objectives, the study seeks to answer the following research questions:

1. How is the FL environment for grade-ten MCs?
2. In what ways are the teacher and students practicing in-class and out-of-class learning activities in terms of FLA?

The present study can be significant in informing school education stakeholders and policymakers to develop provisions for creating conducive FL environments in Nepalese schools. It may also encourage mathematics educators to move into FLA instead of traditional teaching methods for promoting effective mathematics learning. Moreover, this study can support scholars conducting further research on flipped pedagogy in similar contexts and contribute to the existing body of knowledge in this field.

Methodology

Philosophical Perspective and Design

In this research, the researcher followed an interpretive paradigm grounded in relativist ontology, subjective epistemology, and naturalistic methodological procedures (Denzin & Lincoln, 2005). As the study aimed to explore the reality of the flipped learning (FL) environment and its existing practices in mathematics classrooms (MCs) through teachers' and students' perspectives, their observed actions, behaviors and classroom situations, the interpretive paradigm was considered most appropriate. Likewise, the study employed a micro-ethnographic design, as ethnography is a qualitative approach that allows researchers to explore cultural contexts for understanding human behaviors in depth (Harwati, 2019). According to Elias (2003), infrastructures, teaching-learning activities, classroom interactions, and learning behaviors, including psychological aspects, are a collective classroom culture that shapes pedagogical process. Thus, the classroom is a cultural context in which to explore classroom culture in terms of flipped pedagogy; ethnography is well-suited for this study. Moreover, micro-ethnography, particularly, focuses on studying a small-scale context when limited by study time and resources (Fusch et al., 2017). As this research centered on exploring the FL environment and its instructional practices (cultural context) in a Grade 10 mathematics classroom of a school (small-scale context) over a period of 4 weeks (limited time), micro-ethnography was considered a suitable design to conduct the study.

Location, Population, and Participants

The researcher conducted this study in an institutional secondary school, situated in Godawari Municipality of Kailali District, Far Western Province of Nepal, which has encouraged STEAM education since 2017. The school was purposively selected in the sense that STEAM education prompts the adoption of FLA to enhance education quality (Wright & Park, 2022). The research population consisted of two mathematics teachers and 80 students from Grade 10, out of them one teacher and three students, from the observed class, were purposively selected as key participants and indicated as S1, S2, and S3 for anonymity.

Data Collection Methods and Tools

In the current study, relevant information was collected through the methods: direct observation and in-depth interviews, using checklists, field notes, interview guidelines, reflective journals, audio recordings, and photographs as the key tools. Researcher, following the ethical standards for ethnographic research (Creswell, 2012; Ryen, 2009), obtained informed consents from the participants and school authority after clearly describing the research objectives, procedures, and confidentiality protocols. Thereafter, the researcher closely observed the existing classroom environment and pedagogical practices relative to FLA over a period of four weeks. The check-list, photographs, and field notes were properly employed to collect the information. During this period, 30–50 minute in-depth interviews were conducted with each participants, followed by additional questions as needed. All the interviews were audio-recorded and field notes were kept. The open-ended interviews remained significant for exploring FL environment and practices through the participants' experiences, beliefs, and perceptions regarding FLA. Overall, researcher gathered a rich qualitative data in textual, audio and visual forms.

Data Analysis and Interpretation

For analyzing the gathered qualitative data, the researcher transcribed audio-records of interviews and repeatedly reviewed all the data from multiple sources, then systematically coded, and organized them into categories and themes (Creswell, 2012). In this process, the similarities and differences across the data sets were identified via repeated reading and coding, and themes were developed by triangulating the data from different sources. At the same time, based on the established flipped learning frameworks and related theory (such as the FLIP framework, the three-stage FL model by Fung et al. (2021), and Vygotsky's constructivist learning theory), the data were interpreted to ensure theoretical coherence. Regarding the data validation, the researcher triangulated participants' statements and followed member checking while collecting data.

Results and Discussions

This section presents the study findings based on the analysis of gathered data along with the discussions. In the data analysis process, the two research questions were answered, and the respective findings with discussions are included under the following subheadings.

Situation of Flipped Learning Environment in Mathematics Classroom (MC)

Under this subsection, the researcher has incorporated the participants' perceptions and his observations in response to the first research question, intended to explore which explored the status of the FL environment in terms of teachers' knowledge of FLA, digital access and skills, workload, including students' engagement in learning, and teachers' roles in fostering flexible, student-centric, interactive learning. Regarding his Knowledge of FLA, the participant teacher responded,

I heard flipped pedagogy for the first time from you, and I understood its concepts then by searching online. In my view, it is a technology-supported, learner-centric instructional strategy, suitable for digital-era students to enhance their mathematics learning. However, I haven't had its practical experience so far.

This narrative indicates that the teacher was initially unfamiliar with FLA; his participation in the study had encouraged him to expand FLA's conceptual understanding. Even though he didn't have FLA's practical knowledge, he perceived it as a student-centric pedagogical approach effective in fostering meaningful mathematics learning and suitable for the digital-era learners.

Describing the situation for applying FLA in MCs, the teacher further stated,

In our school, we have internet access, a computer lab, and two ICT teachers, for the basic level and secondary level. Students also have digital access at home and they have been habitual using digital resources to interact with peers for their learning since the COVID-19 period, which can facilitate FLA implementation. However, currently, I find it challenging to adopt FLA in MCs because I have a full workload of 6 periods, limited digital competence and insufficient time to prepare quality lecture videos. Besides, students' low motivation for self-regulated learning, inadequate classroom technology (e.g., projectors, smart boards), and school authorities' restrictions on bringing personal digital devices into classrooms further constrain the adoption of FLA.

The findings indicate that the FL environment in the MC remained inadequate to implement FLA as it was conditioned by the teacher's limited digital skills, free time, and heavy workload, including students' low motivation for self-regulated learning and the authority's unfamiliarity with FLA. Though all student participants reported access to digital technology at home, the school administration had restricted bringing smartphones into classrooms. In this regard, one of the participants, S_3, stated, “Smartphones help to capture image of teacher’s solutions and allows us to be more focused in understanding the problems rather than copying the solutions.” The participants further expressed that despite such restrictions, the teacher encouraged online collaboration through a messenger group, promoted in-class discussions and group learning, and provided frequent feedback. Observations confirmed his strong content knowledge and supportive instructional practices (see Fig. 1 & 2).

Figure 1

Teacher Observing Student’s Solution and Providing Feedback

Figure 2

Teacher Supporting Needy Students

Though, I found a lack of interactive digital tools, enough space, and furniture to conduct in-class group discussions and works, students' access to digital technology at home, the teacher's friendly behavior with the learners, preferred group learning activities, and feedback were positive aspects of practicing FLA in the MC.

Regarding the FL environment, Bergmann and Sams (2012, 2015) mentioned some requirements, including an innovative and digitally competent teacher with sound subject knowledge and pedagogical expertise, adequate preparation time, technological access, familiarity with FLA, motivated and self-regulated learners, and supportive parents and school authorities. Likewise, FLN (2014) emphasized four foundational pillars for effective FLA: a flexible learning environment (F), student-centric learning culture (L), intentional content (I) tailored to learners' needs, and a professional educator (P). As the MC lacked several of these requirements and did not fully integrate the FLIP pillars, the environment remained inadequate to implement FLA effectively. Furthermore, consistent with Lo and Hew (2017), the challenges identified in the MC pertaining to teachers, students, and technology impeded the creation of a flexible, interactive FL environment and hindered FLA practice.

In-class and Out-class Learning Strategies Regarding FLA in MC

To explore existing in- and out-class learning strategies in terms of FLA, I observed the MC for four weeks throughout the units: Compound Interest (CI), Population Growth (PG), and Depreciation (D), and have presented classroom observations including the participants' feelings and views in this sub-section.

To develop basic mathematical concepts (CI, PG, and D), the teacher based on the students' relevant pre-knowledge (Simple interest (SI) and compound amount (CA)), followed an active learning strategy with interactions where the teacher's role was to put questions and class works, motivate students to engage in tasks, observing their works and difficulties and supporting them to develop concepts. While students' role was to discuss, do tasks, and reflect. One of the class observations aimed at developing the concept of CI is presented as:

The teacher introducing the topic 'Compound Interest', started to check students' pre-requisites on SI and asked, "What is SI of Rs 1000 for 2 years at 5% p.a. interest rate?" All students replied, "Rs 100 sir." The teacher valuing the responses put a quarry, "If the interest is paid annually and the paid interest again earns interest at the same rate, will the final interest be the same?" Only eight students replied, "No sir, it will be more than Rs 100." Then, dividing the eight students into seven separate benches (groups), the teacher asked to find the amount for the first year. All groups responded Rs 1050. He then allowed them to discuss on second-year principle and to present it. Students presented it as Rs 1050. Thereafter, he asked to find the second-year interest, amount, and the total interest in two years which the groups calculated as Rs 52.5, Rs 1102.5, and Rs 102.5 respectively. The teacher then concluded, "Interest paid at regular intervals of time that includes interest of interest is CI. So, Rs 102.5 is CI". He then provided a similar problem as class work to compute CI in groups, and lastly, assigned students to see the formula derivation for CI from the book at home.

Thus, students constructed a new concept of CI through active discussions and interactions within groups, getting support from more knowledgeable others (teachers and peers) (Vygotsky, 1978). As Vygotsky's social constructivist learning theory forms a basis for FLA's practice (Jarvis et al., 2014), observed activities aligned with FLA. For basic learning in FLA, pre-class activities like watching lecture videos, listening to podcasts, taking key notes, and doing assignments are preferred (Bergmann & Sams, 2012, 2015; Bhagat et al., 2016), of which watching interactive lecture videos is preferred most (Ku et al., 2019) because they provide flexible learning via pause, rewind, and forward options as per the learners' needs (Bergmann & Sams, 2012, 2014; Birgili et al., 2021). However, pre-class lecture videos were limited in the MC due to the above-discussed problematic situations. Therefore, MC restricted out-class flexible learning.

After developing the mathematical concepts, the teacher employed an inquiry-based, interactive approach to guide students in collaboratively deriving the formulas for compound amount (CA), compound interest (CI), population growth (PG), and depreciation (D), providing ongoing guidance and feedback. The observed activities for deriving the CA and CI formulas were as follows:

The teacher, introducing the topic, presented a problem on the board with hints and instructions as: "Suppose, you have principle Rs P, time T years, and rate of interest R% p.a. then what CA and CI will you get at the end of T years. Hints: Interest for the first year, $I_1 = \frac{P \times T \times R}{100} = \frac{P \times 1 \times R}{100} = \frac{PR}{100}$, amount for the first year is $A_1 = P + I_1 = P + \frac{PR}{100} = P\left(1 + \frac{R}{100}\right)$, and interest $I = amount\ (A) - Principle(P)$. Continue this process for $A_2\ and\ A_3$ and share your amounts $A_1, A_2\ and\ A_3$". Then, he remained to observe each group and guide them to express A $_2$ as. Ultimately, all groups expressed in the indexed form. Thereafter, the teacher focused students to observe the pattern of $A_1, A_2\ and\ A_3$ and allowed to express patterns of $A_4, A_5, \ldots\ and\ A_T$. The teacher, writing the patterns on the board, and discussing them concluded that CA in T years was $CA = P\left(1 + \frac{R}{100}\right)^T$ and then students using hint: I = A - P, derived the formula $CI = P\left[\left(1 + \frac{R}{100}\right)^T - 1\right]$. He then assigned a problem: if P = Rs 2000, T = 3 years, and R = 6%, find CA and CI. The students performed well and finally, they were assigned to practice related exercise problems at home.

The observed in-class strategies were aligned with FLA as Muir and Geiger (2016) assert that in FLA, inquiry-based group-learning activities make students actively engaged to explore topics in greater depth through increased interactions including support and feedback from instructor and peers. Similarly, findings are supported by Patterson et al. (2018) who claimed that FL in mathematics, without using technology, preferring group-based in-class active learning and pre-class text-based assignments had increased learners' motivation, engagement, and achievement.

Having students with comprehension of necessary concepts and formulas, the teacher emphasized exercises and problem-solving activities to enhance students' analytical skills. Each session began with a brief review, followed by group discussions and interactions on problems from textbook and old-sets. Discussions, primarily, focused on identifying given information, determining what to find, and outlining solution strategies, supported by the teacher's explanations. Students then, supporting each other, solved the problems in their groups, while the teacher remained monitoring their progress and provided feedback and support as needed (see Fig. 1, 2, 3, 4 & 5). No any test was found conducted during the observation period.

Figure 3

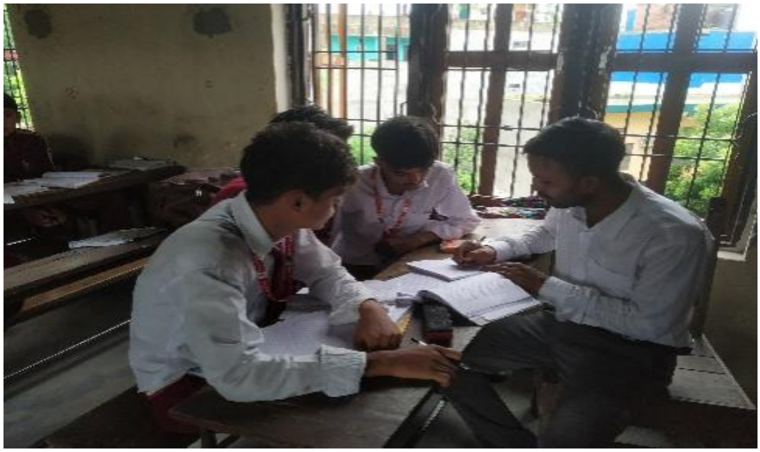
Students Engaging in Solving Exercise Problems

Figure 4

Peer Learning

Figure 5

Teacher Supporting Students in Group



Regarding his in-class strategies, the teacher stated, "Some students have a low level of competency; they don't complete their homework; therefore, I usually allow them to complete exercises in groups and solve problems during the class to enhance their understanding, problem-solving skills, and overall performance in mathematics." He further added, "I regularly monitor students' work and provide feedback to meet the objectives of the class test. Excessive time is taken by the in-class exercises, and unit tests are constrained by insufficient time. However, I usually conduct tests before scheduled examinations." The student participants also expressed similar views regarding in-class strategies as stated by the teacher that I observed during the study period.

According to Fung et al. (2021), for effective flipped MCs, pre-class materials, short in-class revisions, and interactive activities involving discussions, group-work, problem-solving, including teacher and peers feedback and support are essential. Thus, observed in-class activities are evident to align with FLA. Similarly, Cheng et al. (2019) highlighted inquiry-based and problem-solving learning as essential strategies in flipped MCs for fostering higher-order skills in mathematics, which further supports the findings.

In relation to out-class learning, students were found self-learning through textual materials such as textbooks, practice books, and old question sets. They remained engaged mainly in reading the text, doing exercises and solving problems from old question sets. Some students often use YouTube lectures and peer-shared solutions via messenger groups. In this regard, participant S_3 asserted, "I complete exercise problems, practice past questions, share solutions with peers online, and sometimes use online lectures videos to solve difficult problems and clear misconceptions." In contrast, S_1 and S_2 stated that at home, they completed their homework and practiced exercises, and consulted teacher and peers' for their difficulties through messenger. Thus, the findings signify lack of individualized pre-class learning opportunities, due to the teacher's limited digital skills and time constraints. This aligns with Bergmann and Sams (2012, 2015) and Hew et al. (2021), who indicate teacher's lack of digital skills, overloaded teaching periods, and insufficient time to create quality lecture videos and supplementary materials for pre-class basic learning as major challenges to practice FLA, which justifies the above finding.

In sum, the findings reveal that Nepalese secondary MCs currently have an inadequate environment for adopting flipped learning (FL). The major barriers to this situation are attributed to teachers' unfamiliarity with FLA, lack of digital skills, heavy workload, students' low motivation for self-responsive learning, insufficient interactive digital devices, and inadequate administrative and managerial support. As a result, flexible pre-class learning is restricted and relies mostly on text-based materials, with activities completing exercises and assigned work, and solving problems from past question sets. However, in-class practices primarily employ constructivist, inquiry-based, and problem-solving strategies through interactive discussions, group and individual activities guided by teacher and peer feedback, which are rooted on social constructivist learning theory and align well with FLA.

Ways Forward

The existing literature on FL indicated that effectively-designed FL environment and activities positively influence students' engagement, motivation, higher-order abilities and performance through its flexible, individualized, and group-based learning opportunities. However, the current study reveals that Nepali MCs have inadequate FL environments limited by diverse challenges related to teachers, students, technological access, including institutions' administrative and management issues. In this scenario, to establish a proper FL environment for its effective implementation in the MCs of schools in Nepal, some recommendations are proposed below.

Need to Familiarize FLA in School Context

FLA, being an innovative and recently developed instructional strategy, seems relatively unfamiliar to school contexts in Nepal in terms of its concepts, objectives, methods, and outcomes. However, in developed countries, it has been widely adopted as it holds better potential to improve academic quality across all levels and disciplines over traditional teaching methods. Therefore, school authorities, teachers and other stakeholders have to promote FLA's understanding, particularly regarding its concepts, processes, benefits, and challenges through seminars, workshops, and media initiatives. In this context, ERO (2021), MoEST (2019), and NCF (2019) have initially emphasized the integration of innovative, student-centric, and technology-friendly instructional methods for improving educational quality, and FLA can be one such method.

Provide Teacher Trainings and Workshops

Teachers' digital competency and practical knowledge of FL model are considered essential to design and implement FLA effectively in MCs. Teacher's digital skills ensure developing high quality lecture videos which offer independent pre-class learning. While the FLA's practical knowledge help teachers to design in-class active learning activities and practice them effectively. As this study reveals, mathematics teachers' deficiency of technological skills and practical experience of FLA, school authorities should strengthen their digital and pedagogical capacities through conducting targeted training and workshops. In this regard, Joshi et al. (2021) highlighted developing practical ICT skills of mathematics teachers to support constructivist and innovative pedagogical practices in Nepal's secondary schools.

Motivate Teachers and Students by Creating a Proper Learning Environment

It is significant to motivate both mathematics teachers and students to move into the flipped model for improving mathematics teaching and learning. School authority can play a crucial role in fostering the adoption of this approach through developing favorable FL environment by developing digital and physical infrastructures, supportive administrative and management provisions and motivating students using digital tools for self-regulated learning. As the study's findings indicate inadequate FL environment in terms above aspects, school authorities should establish a conducive FL environment and encourage teachers and students to employ FLA in MCs. Furthermore, the Curriculum Development Centre (CDC) and its mathematics curriculum committee should prioritize the creation and distribution of high-quality lecture videos to ensure easy access for teachers and students.

Need to Include FL Strategy in University Courses and School Mathematics Curriculum

Various mathematics education programs in Nepal (1-year B.Ed., 3–4-year B.Ed., and 2-year M.Ed.) aim to prepare prospective school teachers and include some ICT-related content and teacher training for licensing and career advancement. However, these programs rarely incorporate the flipped learning approach (FLA) as an instructional strategy. Therefore, curriculum designers and relevant authorities should integrate FLA to familiarize future mathematics teachers with its application. Likewise, the NCF (CDC, 2019) emphasizes ICT use, teacher capacity building, and learner-centered, collaborative methods. Although the Grade 9–10 mathematics curriculum lists multiple instructional strategies, FLA, despite encompassing many of them, is absent and should be included to support its recognition and implementation in school mathematics classrooms.

Conclusion

Flipped learning approach (FLA) is an innovative, student-centered instructional strategy that leverages technology to enhance educational quality and transform traditional teaching methods. By combining pre-class individualized learning through online lectures videos and supportive materials with the in-class collaborative and interactive activities, FLA fosters higher-order learning and can positively impact students' motivation, engagement, comprehension, problem-solving skills, and overall performance in mathematics.

Following a micro-ethnographic design, this study explored the FL environment and examined its practices in a Grade 10 mathematics classroom. Findings indicated that, despite students having access to technology, being habitual in using digital devices, and teachers' use of learner-centered methods, FL environment currently remained inadequate to adopt FL model in MCs in Nepal. The key barriers for the inappropriate FL situation were attributed to the teachers' lack of practical knowledge of FLA, deficiency of digital skills and free time, and high workload; students' low motivation for self-responsive learning; and institution's administrative management issues. As a result, out-class flexible learning was restricted and involved only the usual text based activities. However, in-class practices reflected constructivist, inquiry-based, and problem-solving strategies involving discussions, interactions, solving exercises problems individually and collaboratively, and feedback and support from the teacher and peers which aligned with FLA.

The present study seems significant to provide valuable insights for stakeholders of school education and policymakers to put their attention and make provisions for creating favorable FL environment, addressing existing implementation barriers, and promoting effective practice of FLA in secondary mathematics classrooms. To obtain more generalizable findings, further extended ethnographic research involving diverse schools and larger participant samples is recommended.

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